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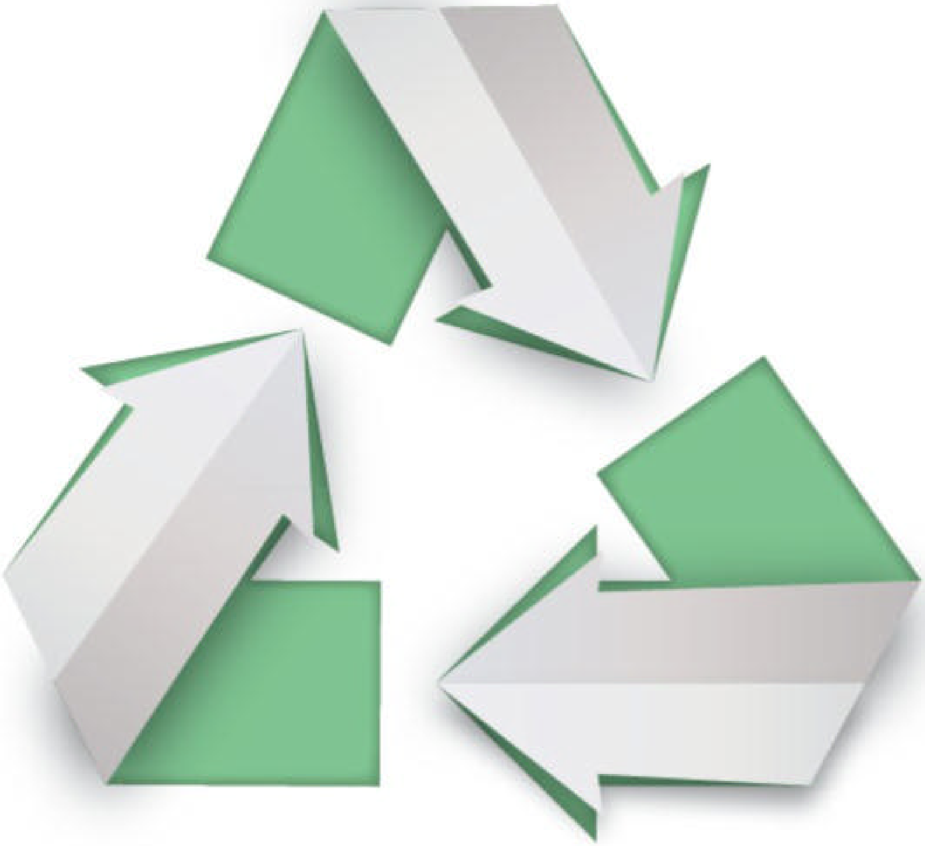

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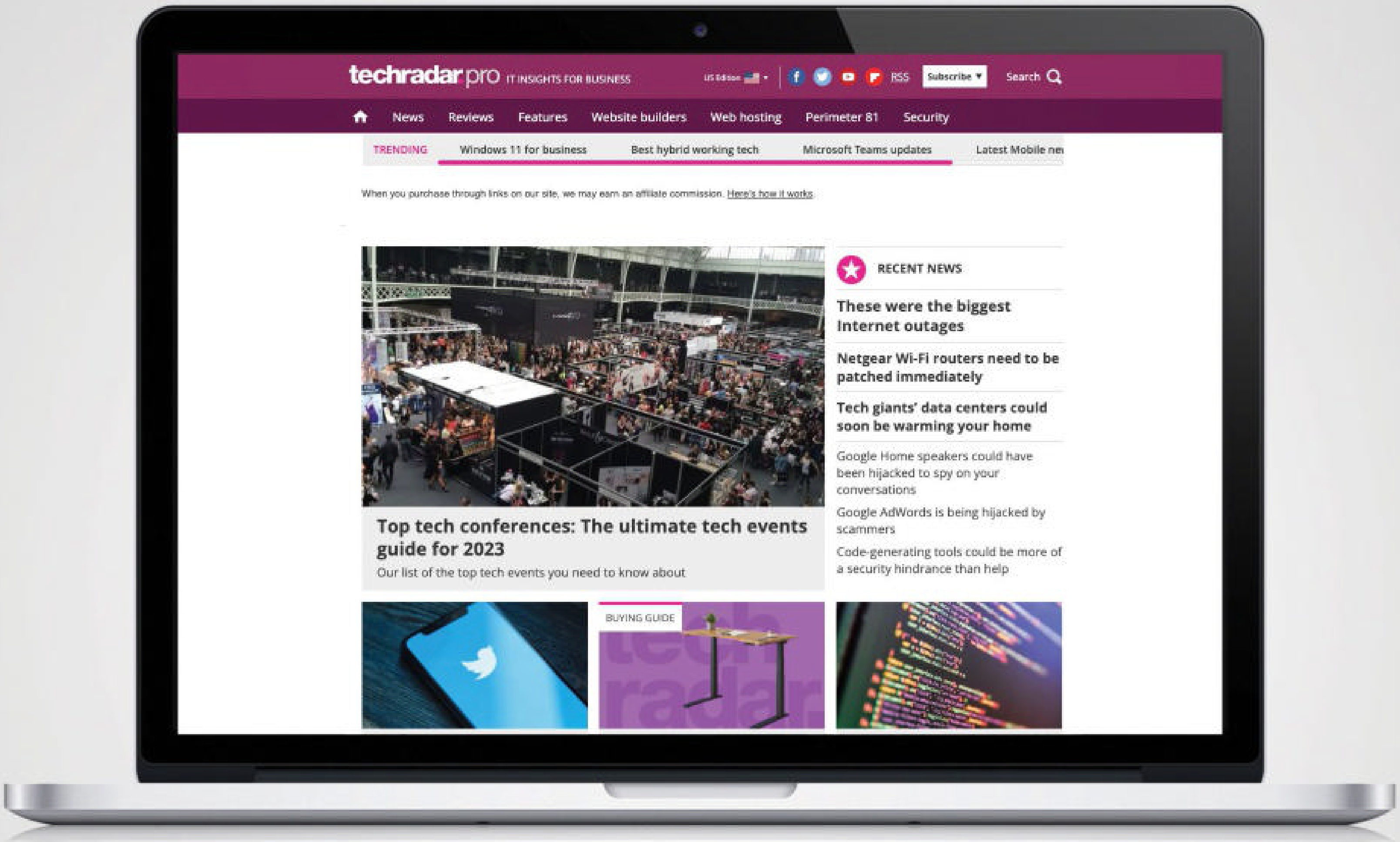

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Guy
Cocker

GOOD THINGS COME IN SMALL PACKAGES

LIKE MANY OF YOU, I'm a member of quite a few WhatsApp groups across family, friends, and colleagues. One such group of journalists and PRs in tech has been spamming my chat with their attempts to take the latest CPUs and GPUs, and fit them into as small a PC as possible. In the past, that's been a challenge, but this generation's chunky RTX 4000-series cards in particular make it more difficult than ever. Undeterred, they've been swapping ideas on cases, egging each other on with ridiculous cooling solutions, and posting the results to Reddit where they've been lapping up praise.

That's why this issue, we're doing our own small form factor build. You've no doubt looked at (or already bought) the latest gear from Intel, AMD, and Intel—now we show you how to fit it all into a chassis that's small enough to sit under the TV or be tucked out of sight on a desk. Our build is easier to put together than many you'll see on r/sffpc, as it uses Intel's latest 13th-generation NUC system, which includes a motherboard, processor, liquid cooler, and many other components. It's also big enough to fit an RTX 4070Ti, which is what we've used in the build, no waterblock installations required. It's a cutting-edge, sleek, and easy-to-build micro PC, and our builder Sam shows you how to do it from page 16. He's also compiled a list of the best ultra-compact cases for those who want to take things further.

This month, I headed to Las Vegas for the Consumer Electronics Show. After last year, where I wandered the empty halls looking for something, anything to write about, this year's show was an embarrassment of riches. PC tech felt like the biggest story, with so many great laptops and displays, I sadly couldn't include them all even in a 10-page feature, starting on page 32. If you're in the market for a new portable PC or monitor, I would urge you to check out the feature to see what's coming before splashing out. With RTX 4000 series graphics hitting laptops this year, as well as high refresh rate OLEDs set to become the norm, 2023 is looking like a classic year for PC fans.

However, we're acutely aware of how expensive everything has gotten this year, which is why we thought it was a good time to highlight our favorite free apps and downloads on page 44. Whether it's tools for web browsing, work, or entertainment, we've got the best ways to boost your PC without spending a dime. On page 52, we map out the modern motherboard to help explain what the backbone of your PC system does. Plus, we cast our eye over two big new products, Nvidia's new RTX 4070Ti GPU (page 74) and Samsung's Odyssey Neo G8 monitor (page 76).

I'm aware we've been giving lots of love to Intel and Nvidia's new products in our cover builds in recent issues, so next month, Sam will put together an AMD-based system for fans of Team Red. The company's GPUs, in particular, look better value than Nvidia's equivalents, but is it worth building a system around them? Find out in the next *Maximum PC*, on sale 28th March.

Enjoy the issue!

Guy Cocker

Guy is Maximum PC's Editor-in-Chief. He built his first gaming PC in 1997 to play Tomb Raider *on 3dfx, and has been obsessed with all things PC ever since.*

↘ submit your questions to: editor@maximumpc.com

THE NEWS

Intel stakes World's Fastest Chips claim

Company claims both desktop and mobile crowns

BEING ABLE to claim you have the world's fastest processor has an undeniably attractive ring to it. You might not make the most efficient, best value, or any other metric you care to pick, but if you make the fastest chip, you have major bragging rights. Intel has been claiming that crown for years, though it has had to fight increasingly hard for it recently, as AMD's Zen-powered chips edge ever closer. But it's not about to lose that crown without a fight.

If your rival gets close, there is a simple tactic—take your best chip, then carefully select the best ones you can find, and crank the frequency up as far as you dare. Enter Intel's Core i9-13900KS, which is an aggressively binned 13900K, and configured to run at a maximum Turbo Boost of 6GHz on one or two of its performance cores, up from the standard part's 5.8GHz. It's the first desktop processor to hit that magic number, although a quick bit of math tells us this is not quite 3.5 percent faster than the regular i9-13900K.

The recommended price for this speedster is $699, but you'll be lucky to find it for that. Expect to pay about $750 as supplies are limited and demand is brisk, despite the marginal gains. That's $200 or so over a regular 13900K, which shows what Intel thinks people will pay for the very best. What you do get, though, is a chip that has been thoroughly tested, and is about as robust as they come. This will come in handy if you start fiddling with non-standard settings.

Do Intel's claims of world domination ring true? There's a problem—AMD's Ryzen 7950X3D, for gaming at least, is going to be a tough nut to crack and Intel's boast may prove to be short-lived. However, the final numbers are impressive, and 6GHz catches the headlines. Intel's PR department says it "represents a major milestone in the PC industry". Whether it's an exercise in marketing more than anything else, it's an impressive piece of silicon.

Intel also claims the world's fastest mobile processor, as its 13th-generation chips reach the laptop. The Core i9-13980HX has 24 cores—eight performance and 16 efficiency, the clock tops out at 5.6GHz, it has a PBP (Processor Base Power) of 55W, with a maximum draw of 157W at full tilt, and will cost $668. Alongside this monster, Intel also released a whole family of 13th-gen mobile chips, over 30 in all, in four groups—the 55W HX, 45W H, 28W P, and 15W U varieties.

Intel also fleshed out its range of Raptor Lake desktop chips with a series of non-K parts, both 65W and 35W. There are 16 in all, so we'll spare you a full run-down. The top 65W part is the Core i9-13900 at $546, which has a maximum clock of 5.6GHz. The range drops down to the i3-13100, which has just four performance cores and costs $134. There are 'F' variants of the chips that lack integrated graphics, but these only save $20. The 35W chips carry the 'T' suffix and are topped by the i9-13900T ($549), which gets the full 8P and 16E core count but is throttled to keep power draw down. Intel estimates these 13th-generation chips offer performance bumps of between six and 40 percent on their 12th-gen equivalents, depending on the task.

Meanwhile, Intel is set to build its first tile-based chip this year, Meteor Lake. This also brings a change in nodes, from Intel 7 to Intel 4 (equivalent to 10nm, and 7nm). Persistent rumors indicate that Intel may not produce desktop versions of this at all, keeping it for mobiles only and using a planned refreshed Raptor Lake instead.

Apparently, Meteor Lake isn't proving competitive enough to grace a desktop, being unable to hit the higher clock rates. Intel has announced that the compute tile is ready for manufacturing, but there seem to have been production issues with the new process. Information is scarce, and Intel is uncommunicative, but it does seem as if the blue team has hit a snag in its ambitious release schedule. Luckily, Raptor Lake is a solid performer, as those 'world's fastest' claims show. **–CL**

© INTEL

> The new king of the hill, the i9-13900KS, hits the magic 6GHz out of the box.

NVIDIA'S MARKETING MESS

POOR PERFORMANCE AT HIGH PRICES

Read our Nvidia GeForce RTX 4070 Ti review, p.74.

THE 12GB GEFORCE RTX 4080 was poorly received. As a step down from the 16GB version, but with a premium price, it quickly vanished. Now it's back, this time called the RTX 4070 Ti, and costs $100 less at $799. It has a claimed performance better than the 3090 Ti. Problem solved? Not quite. It still isn't pushing pixels fast enough—struggling to match a 3090 Ti in tests that Nvidia hasn't cherry-picked, it even drops near 3080 territory at times. The price/performance is still out of whack (see review, page 74). Dropping down the running order, Ada Lovelace isn't panning out too well, casting a shadow over the forthcoming 4070 and 4060 Ti, which will presumably be slower still. The 4070 Ti is in limbo here, neither reasonable value nor properly fast, but despite this, it is apparently selling well. It just shows how few decent options there are for gamers at the moment. **–CL**

HOT RADEON 7900 CARDS

Faulty vapor chamber to blame

NOT EVERYBODY has been completely happy with their new Radeon RX 7900 XTX cards. It wasn't long before reports started appearing of cards overheating, hitting 110°C at the hot spots and triggering thermal throttling. As you'd expect, people were pretty vocal online, though AMD was initially unsympathetic, insisting that things were "within spec". People got more organized, passing serial numbers to AMD, and things improved.

The problems only seemed to affect the AMD reference designs, which points to the cooler. AMD's investigation found that "a small number" of cards were released without enough water in their vapor chambers. If you have a hot card, the advice is to return it, although replacement stocks are currently in short supply. This is an embarrassing failure from AMD. The reference design is just that—a design that shows others how it should be done and getting it wrong isn't a good look. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **NO MORE DRIFT**
The Nintendo Switch's Joy-Con can be fixed using parts from Guliket, which use magnets instead of moving parts.

✓ **FIX IT YOURSELF**
John Deere is to provide the diagnostic tools required to fix your own tractor—a victory for the right-to-repair campaign.

✓ **A RARE FIND**
A deposit of over one million tons of rare earth oxides has been discovered in Sweden.

TRAGEDIES

✗ **ARTIFICIAL IDIOT**
An AI system developed by a Pentagon agency to recognize humans was foiled by people wearing cardboard boxes.

✗ **TESLA FAKES AUTOPILOT**
A Tesla engineer has admitted a video showing a self-driving Model X was fake, as drivers had intervened several times.

✗ **MICROSOFT DITCHES VR**
Microsoft has fired 10,000 employees, including most of its VR and HoloLens staff.

© AMD

ZEN 4 V-CACHE LANDS

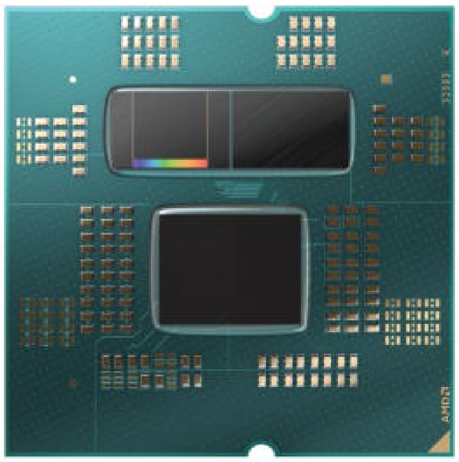
Sixteen cores, 144MB of cache, a gaming monster

EVERYBODY was impressed by the Ryzen 7 5800X3D, a Zen 3 chip with 96MB of L2 cache that was claimed to be the world's fastest gaming processor at the time. We've been waiting for the Zen 4, and AMD has now confirmed three new versions—the Ryzen 9 7950X3D and 7900X3D, and the Ryzen 7 7800X3D. The top dog 7950XD has 16 cores and a maximum clock of 5.7GHz. That extra cache pushes the total to 144MB of L2, which is Threadripper territory.

The middle chip has 12 cores and a top clock of 5.6GHz, while the Ryzen 7 has eight cores, a clock of up to 5.0GHz, and a TDP of 120W. They aren't unlocked but settings such as the precision boost overdrive, curve optimizer, and memory can be tweaked.

These chips spell trouble for Intel, as the 7950X3D should be a gaming powerhouse. AMD puts it at between 13 and 24 percent faster than the Core i9-13900K on selected titles. Similarly impressive claims are made for productivity, including a 17 percent lead using Adobe Premiere Pro. AMD initially quoted a release date of 14 February, but it should be any time now.

AMD also released a series of mid-range 65W non-X Ryzen 7000s—a 12-core Ryzen 9 7800 ($429), an eight-core Ryzen 7 7700 ($329), and a six-core Ryzen 5 7600 ($229). Clock rates have been lowered over the X versions, the 7700 losing a full Gigahertz. We also get the Radeon RX 7600M and 7000S graphics cards for laptops using the latest RDNA 3 architecture. AMD also has a range of laptop chips, from the Zen 4 7045, and 7040 series, through Zen 3+ 7035, Zen 3 7030, to the Zen 2 7020. The 7045 has up to 16 cores and the 7040 carries RDNA 3 graphics and dedicated AI silicon. **–CL**



The V-Cache version, the Ryzen 9 7950X3D, is the Zen 4 chip we've been waiting for.

NEW MACBOOK PROS AND MINIS

Debut of the M2 Pro and M2 Max processors

APPLE'S TRANSITION to M2 brings two new MacBook Pros and two new chips: the M2 Pro, and M2 Max. We also have new M2-powered minis (Apple uses a lowercase 'm' here for some reason). This means Apple has now moved all its kit over to its own silicon bar the Mac Pro, which still sports Xeons. The M2 Pro is a double-size M2 built using a second-generation 5nm process. It has a 12-core CPU (up from 10), a 16-core neural engine, a 19-core GPU, and twice the memory bandwidth.

The M2 Max adds a 38-core GPU and doubles memory bandwidth again, now reaching 400GB/s. The new MacBook Pros come in 14-inch and 16-inch versions. Memory options run from 16GB to 96GB, and storage from 512GB to 8TB, depending on your chip option: both can be specified with an M2 Pro or M2 Max. Other than the new silicon heart, these are pretty much the same as the previous generation.

As expected, this is the most powerful MacBook yet, and Apple claims it's six times faster than an Intel-powered MacBook. Meanwhile, the new Mac mini gives you a choice of a regular M2 or an M2 Pro. The 14-inch M2 MacBook Pro starts at $1,999, while the 16-inch model can reach $6,499 if you want every hardware option. The M2 mini starts at $599 and runs to $4,399 for a fully loaded version.

Steve Jobs wasn't keen on them, but Apple is also due to bring touchscreens to MacBooks, according to 'reliable sources'. Jobs is no longer the gatekeeper though, and Apple has decided that touchscreens are part of the Macbook's future. Apple is something of a hold-out here, as touchscreens are everywhere. Adding touch support to the macOS will also remove a bar to using macOS on an iPad, or even iPadOS on a laptop, although Apple will keep the two as separate product lines for now. The touchscreen is first expected to appear in an OLED-equipped MacBook Pro in 2025. **–CL**

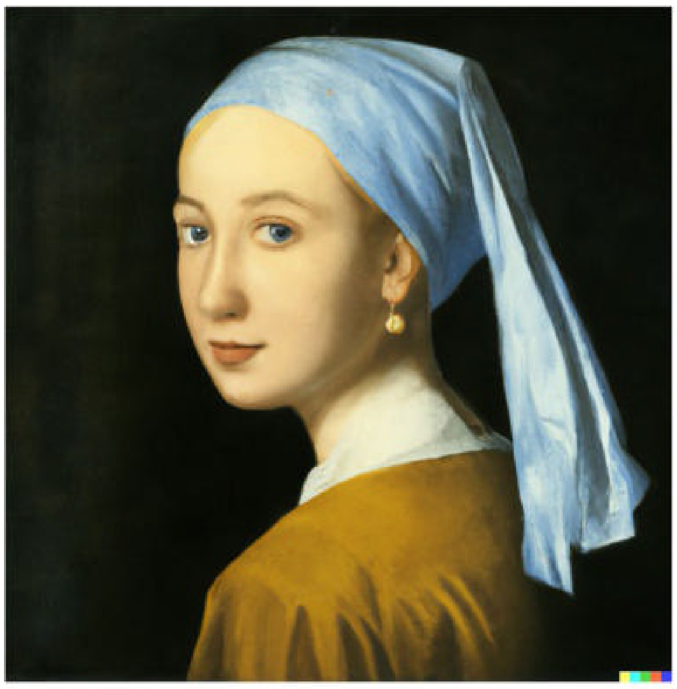
Microsoft drops $10 billion on OpenAI

MICROSOFT SEEMS to have retreated from the metaverse and is tightening its belt across the company, but one technology it is still backing is AI, having just invested $10 billion into OpenAI. This AI research laboratory is responsible for the amazing DALL-E, the image generator, and ChatGPT, a sophisticated chatbot that can do a lot more than just chat. These two projects captured the public's imagination and helped push OpenAI's valuation to $29bn. Microsoft has been working closely with OpenAI for a while and has already made two previous investments in the company.

Four years ago, Microsoft started work with OpenAI on the Azure OpenAI Service, which it has just made available, and is set to gain ChatGPT shortly. Now Microsoft is betting big enough for Wall Street analysts to take notice, causing a little spike in its stock price. This is now being seen as an opportunity for Microsoft to recapture some of its lost market share.

Microsoft's CEO, Satya Nadella, said the company will be integrating OpenAI software into a range of Microsoft products, including Designer and Bing. This raises an intriguing question—could this put Bing back in contention as a search engine? Google dominates the market and has become synonymous with internet searching. If Microsoft can eat into that market share, it will affect Google's revenue.

AI is huge and only getting bigger. DALL-E and ChatGPT are generative AI, producing content without human input. Pictures, video, audio, and text can all be easily created—some pundits predict that 90 percent of online content will be artificially created within three years. That sounds a lot, but the impact will no doubt be sizable. Microsoft has invested hugely in cloud services and now the AI to power it. This looks like a smart move.



DALL-E is capable of amazing work as this AI-created variation on Vermeer's Girl with a Pearl Earring shows.

Win10 is dead

From January, you can no longer buy a Windows 10 license, so it's Win11 or nothing. This should at least push the adoption numbers up—there are 1.4 billion Windows systems and only 16 percent are on Win11, meaning the majority are now running a 'legacy' OS. Win10 will receive full support from Microsoft until October 2025. Win7 has just come to the end of its three-year Extended Security Update, with important security patches. Win8.1 has also reached the end of its support but was never popular. Old versions of Windows tend to die slowly, so Win10 should be fine for a few years yet. Win7 had 13 years of support, and given the slow migration to Win11, we can expect a similar timescale here. **–CL**

Battlemage next year

Intel entered the graphics card market with a fanfare, but things have gone quiet. Its first Arc Alchemist cards were adequate low to mid-range options, but it is playing a long game. A leaked slide showing the Arc Discrete graphics card roadmap appeared online, showing Intel's second-generation Arc cards, Battlemage, aren't due until early 2024. First will be the 225W BMG-G10 chip, aimed at the enthusiast market's 'sweet spot', followed by a 150W performance part. Battlemage will include next-gen memory sub-systems, better architecture and ray tracing, plus other improvements. The market needs more affordable mid-range cards now, so Intel's slow approach is frustrating. **–CL**

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Jarred Walton

TECH TALK

The 7900 XTX's cooling system features a vapor chamber but, unfortunately, some batches of reference cards had a flaw here.

AMD RX 7900 XTX Vapor Chamber Woes

FOR A MONTH OR TWO, Nvidia was in the hot seat due to the melting 16-pin adapters on its RTX 4090 graphics cards. An investigation determined that the root cause was users failing to fully insert the plug into the receptacle. With a bit of wiggling, the connection could come loose and start arcing, causing the plastic around the socket to melt. As you can imagine, AMD was pleased with its decision not to use the 16-pin connector on its cards.

Several prominent people at AMD mocked Nvidia's snafu, with one proclaiming "We're going to kick Nvidia's ass!" Another tweeted an image of the dual 8-pin connectors on AMD's RX 7900 card with the text, "Stay safe this holiday season."

Egg, meet face. AMD has had to acknowledge that batches of its reference RX 7900 XTX cards have an even bigger problem: they are overheating, throttling, and underperforming. AMD has vowed to replace the faulty cards but, by all accounts, the problem with the reference XTX cards is more widespread than Nvidia's melting adapter.

AMD's full statement reads: "We are working to determine the root cause of the unexpected throttling experienced by some while using the AMD Radeon RX 7900 XTX graphics cards made by AMD. Based on our observations, we believe the issue relates to the thermal solution used in the AMD reference design and appears to be present in a limited number of cards sold. We are committed to solving this issue for impacted cards."

Further details implicate the XTX vapor chamber. Vapor chambers are basically a higher-performance take on heatpipes. You have a large chamber with a bit of liquid inside, and the heat from a GPU causes the liquid to evaporate. That phase change helps to wick away a large amount of energy, and then the vapor spreads through the chamber and condenses on the cooling side that's attached to the radiator fins. With AMD's RX 7900 XTX, there's a fine-grained wire mesh on both the top and bottom surfaces to help with the process.

> “It is a few orders of magnitude worse than Nvidia's mistake with melting 16-pin adapters.

The amount of liquid and the pressure inside the chamber are key factors that need to be carefully controlled. Too much or too little of either and the evaporation and condensation process won't function properly. However, around four to six batches of the cooler didn't have sufficient liquid placed within the chamber. The result is that the cooling capacity is greatly reduced.

In the case of the RX 7900 XTX, affected cards can quickly reach hotspot temperatures of 110°C, at which point they begin to throttle. Depending on how bad the problem is, users might lose anything from a few percent to as much as 10 percent in performance, but that's only part of the problem. The 110°C hotspot also causes the fan speeds to ramp up by as much as 1000rpm, leading to a much noisier system, and long-term failure.

So, AMD is doing the right thing and replacing the affected cards, but compared to the roughly 50 cases of melting 16-pin adapters Nvidia was dealing with, AMD is potentially looking at replacing the coolers on thousands of cards—5,000 seems to be a reasonable estimate. That's a few orders of magnitude worse than Nvidia's mistake.

So, how can you tell if you have one of the affected cards? First, it's only the 7900 XTX 'Made by AMD' reference cards that are affected. If you have a 7900 XT or a custom design 7900 XTX, you're in the clear. Beyond that, AMD says to monitor card temperatures while gaming, and in particular the GPU hotspot temperature, to see if it's hitting 110°C—we'd suggest using FurMark with the GPU oriented in a horizontal position as a quick check. If that happens, you likely have an affected card.

In more bad news, AMD had run out of replacement cards at the time of writing, meaning it could be a few weeks before more replacements become available—hopefully by the time you read this.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

THE LIST

THE TOP FIVE STEAM DECK ACCESSORIES

RECENTLY CELEBRATING its first birthday, Valve's Steam Deck portable games console has arguably been the developer's most successful piece of hardware to date. Fans of the machine not only extol its virtues as a great device for gaming on-the-go but also credit it for helping them get back into PC gaming in general. If you have the machine or you're thinking of getting one, here are the best accessories to pair with your Steam Deck for the premier possible gaming experience.

5

JBL QUANTUM TWS EARBUDS

There are plenty of wireless earbuds on the market with wildly varying prices, but these JBLs offer all of the features you'd want, and good sound quality, at a reasonable price. Those features include active noise-canceling, Bluetooth 5.2 support, plus a USB-C wireless dongle for use on a PC. The JBL phone app also allows you to tune them to your ear canal to enhance the ANC performance.

www.jbl.com $150

4

SONY PLAYSTATION 5 DUALSENSE WIRELESS GAMEPAD

Of course, Valve has its own official Steam controller and you can't go wrong with the Xbox Elite Series 2. But our vote goes to Sony's model because of its sleek looks, travel-friendly weight, and ease of pairing. It also has a trackpad, fantastic haptic feedback, and those superb adaptive triggers. It's durable and relatively good value compared with the competition—a rather miserly ten-hour battery is the only drawback.

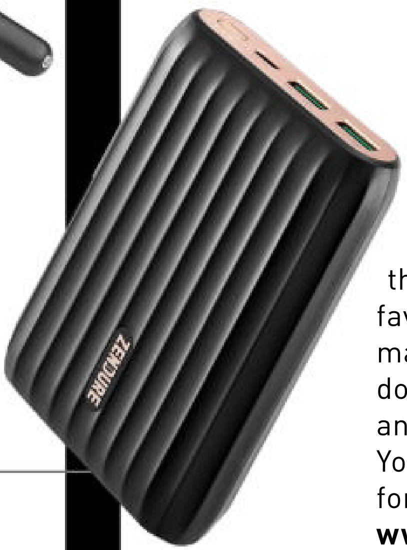
www.playstation.com $70

3

ANNAPRO CARRYING CASE

You can get smaller carry cases for the Steam Deck, but the Annapro is a catch-all solution with room for the controller, power bank, and dock on this list, as well as a smartphone—and enough space between to prevent them from banging together while on the road. The hard case offers excellent protection, but it's also comfortable to wear and some may even say stylish.

www.amazon.com/stores/annapro $34



2

ZENDURE X5 POWER BANK

The Steam Deck is great, but demanding games drain its battery in under two hours. If you're away from a wall socket, you'll need a battery pack, and this one from Zendure is our favorite. It supports the console's maximum 45W Power Delivery, doubles as a data transfer USB hub, and feels well-built. The downside? You'll need your own USB-C cable for that fast charging feature.

www.zendure.com $99

1

JSAUX M.2 DOCKING STATION FOR STEAM DECK

This Jsaux Docking Station comes with USB-A and USB-C ports, HDMI out, plus a PCIe Gen3 M.2 slot for expandable storage, making this the Steam Deck dock to rule them all. The addition of an SSD, as well as a newer HDMI 2.1 port that supports 4K 60Hz, makes this a better choice than Valve's own official dock. It's a little pricier than the official dock, but you also get some Steam Deck skins and a portable stand included in the package.

www.jsaux.com $109

© JBL, SONY, ANNAPRO, ZENDURE, JSAUX

Jeremy Laird

TRADE CHAT

OLED screen tech is finally here, but I'm not feelin' it

IT'S BEEN A LONG WAIT for OLED technology to make the jump from HDTVs to the desktop PC. Now it's finally happening, it turns out OLED isn't all it's cracked up to be, though not for the reasons you might expect. Among the slew of new OLED PC monitors announced at CES 2023, there's not one I'd want. So what's going on and why is OLED disappointing on the PC?

Burn-in, or the fear of it, isn't my issue with OLED. I've been running an Alienware laptop with an OLED panel for the last 18 months with no issues. However, it is a contributing factor when it comes to panel brightness and that's a problem with the first generation of OLED monitors. As with any new technology, OLED comes with novel metrics in terms of specifications and performance. Most notably, measuring OLED panel brightness is more complicated than with LCD monitors, including the latest mini-LED monitors with complex full-array dimming. OLED brightness varies depending on how much of the panel you are lighting up, with the net result that a single spec is no longer meaningful.

A case in point is the Xeneon Flex, Corsair's monster new 45-inch OLED monitor. That rocks a 1,000-nit peak brightness rating, which sounds like plenty. Problem is, the Flex only achieves 150 nits of full-screen brightness. In between, Corsair claims 450 nits for 25 percent of the panel and 800 nits for a 10 percent window. It's hard to grasp how those specs translate into a real-world experience, but the Xeneon Flex looks disappointing on a Windows desktop and with brighter scenes in games and video. It only delivers the kind of eye-popping experience you'd expect from a $2,000 monitor in darker scenes punctuated by bright objects. Those bright points sizzle in contrast to the per-pixel perfect black levels of OLED tech.

Admittedly, Alienware's 34-inch OLED monitor is better when it comes to full-screen brightness. It uses Samsung OLED tech, which seems to have the edge for brightness in PC monitors. The Corsair screen has an LG panel. But even the Alienware 34 is miles off a good LED-backlit LCD monitor when it comes to full-screen punch.

The other problem shared by Alienware and Corsair is pixel density. Both the Corsair and Alienware screens run 3,440x1,440 resolution. OK, the 45-inch Corsair has more of an issue with pixel pitch running that resolution than the 34-inch Alienware. But in either case, it's hard to get your head around paying so much for such a modest resolution when 4K panels can now be had so cheaply. Even 4K 144Hz monitors can be had for about half the money of the Alienware, let alone the Corsair monstrosity.

Unfortunately, I don't see either problem being solved soon. The reason why OLED monitors are relatively low resolution is that they are derived from the same OLED substrates used for manufacturing HDTV panels. The Alienware has the same pixel density as 42-inch OLED TVs, while the Corsair panel aligns with 55-inch TV panels.

For now, it seems it's only cost-effective for monitor makers to run with these HDTV-derived panels rather than tool up with something more dense, such as 32-inch 4K or 34-inch ultrawide 5K2K, either of which would be a much better fit for the premium pricing OLED monitors currently command. As a consequence, there was nothing at CES with a high-density panel.

As for the brightness issue, there's nothing currently available that I'd be happy with, even if the pixel density was right. I don't expect that to change for a few years—both LG and Samsung announced brighter OLED panels for TVs at CES, but it's incremental stuff. We'll have to wait for the perfect PC monitor that delivers the per-pixel lighting, peak contrast, and fast response of OLED with decent pixel density and punchy full-panel brightness.

CORSAIR
XENEON FLEX
DEVELOPED WITH
LG Display
OLED TECHNOLOGY

$2,000 for a 3,440x1,440 45-inch monitor? No thanks!

© CORSAIR

Six raw 4K panels for breakfast, laced with extract of x86... Jeremy Laird eats and breathes PC technology.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Smashing Laptops?
> Boot Screen Repeat
> Make a Leap to SSD

Secure Dead Laptop

My Lenovo Yoga laptop died last year and is still sitting in a drawer at home. I'd like to recycle it, but it contains lots of personal data that I can't delete because I can't boot it up. I thought of removing its internal storage but that's easier said than done because the unit is glued together. I've seen YouTube videos in which people use a heat gun to soften the glue so they can prise the back off. Is that really what you have to do these days to disable a redundant device? Or would you advise using a hammer?

— Roger Hughes

THE DOCTOR RESPONDS: Taking a hammer to your Yoga might be tempting, but we wouldn't recommend it. The lithium-ion batteries in modern mobile devices are energy dense and, if pierced, can explode into flames and produce toxic fumes.

Your question highlights a real concern, however, and there's no single solution. In your case, the best option is the one you suggested: open the device and remove the hard drive or SSD. You didn't say which model of Yoga you have, but iFixit hosts hundreds of illustrated guides that explain how to take apart various devices. The Yoga section is at (tinyurl.com/3rrrehyk).

When you get to the drive, you could remove it and smash it. But as it probably still works, a better option is to connect it to a PC using a cable. If it's a SATA drive, for example, you need a SATA-to-USB cable for around $10 (tinyurl.com/5dfxsh58).

AirPrint Upgrade

I've been an avid reader of *Maximum PC* for many years, so I hope you can help me. I have a Canon MG6150 printer (pictured, opposite page) that connects wirelessly to my PC. My children bought me an iPad, which I've tried in vain to connect to the printer.

Apparently, I need a printer that supports AirPrint, but mine doesn't. It seems a waste to replace a perfectly functioning printer, so I hope you can help me get around this problem.

— Bill Green

THE DOCTOR RESPONDS: You've already outlined the basic problem, which is that your printer doesn't support AirPrint. Your model was manufactured in 2010, a few months before Apple launched AirPrint. Since then, various developers have created paid-for Windows tools that attempt to bring AirPrint to incompatible printers.

However, finding ways around Apple's ever-evolving security is tricky for developers, so something that works today might not work tomorrow. That's why we don't recommend paying for any of these products.

So, where does that leave you? Well, you can print directly from SD memory cards. You could buy an adapter that lets you copy photos from your iPad to an SD card via the Files app, then print them directly from this. Apple sells such an adapter, but it costs $30 (tinyurl.com/rysjab8f). Thankfully, third-party adapters are available that work just as well but cost around $10 (tinyurl.com/bpaf8bm8).

Or, you could upgrade your printer to one that supports AirPrint. Obviously, that's not the eco-friendly option, but most modern wireless printers, even the really cheap ones, do support AirPrint.

Boot Screen Before BIOS

Every time I start my PC, a message appears telling me to press F1 to enter the BIOS settings. When I do this, it takes me to a second screen. I don't have a clue what it is or what to do, so I just press F10 to select the 'Save and exit' option, and then the PC starts up and runs normally. Having to do this every time isn't good for my blood pressure. Can you help?

— Ron Cushing

THE DOCTOR RESPONDS: This is usually a sign that the CMOS backup battery on your PC's motherboard has run out, which means that when you switch off the mains power to your PC, you are in effect resetting the BIOS. That's why your PC asks you to check the settings each time you switch it back on. Although having to press F10 to save and continue is an annoyance, it's no cause for alarm.

Fitting a new CMOS battery is usually an easy job. We gather from the photos of the BIOS screen you sent us that your computer has an Asus Prime B250M-K motherboard,

© LENOVO

↘ submit your questions to: doctor@maximumpc.com so we can even show you exactly where the battery is. Buy a new CR2032 battery, costing around $6 for four (tinyurl.com/mrnx4c5f), then open the PC.

Simply prise out the old cell and pop in the new one. The next time you press F10 to save and exit the BIOS screen, your PC will save the settings, and you won't have to do it again in the future.

Back(up) To The Future

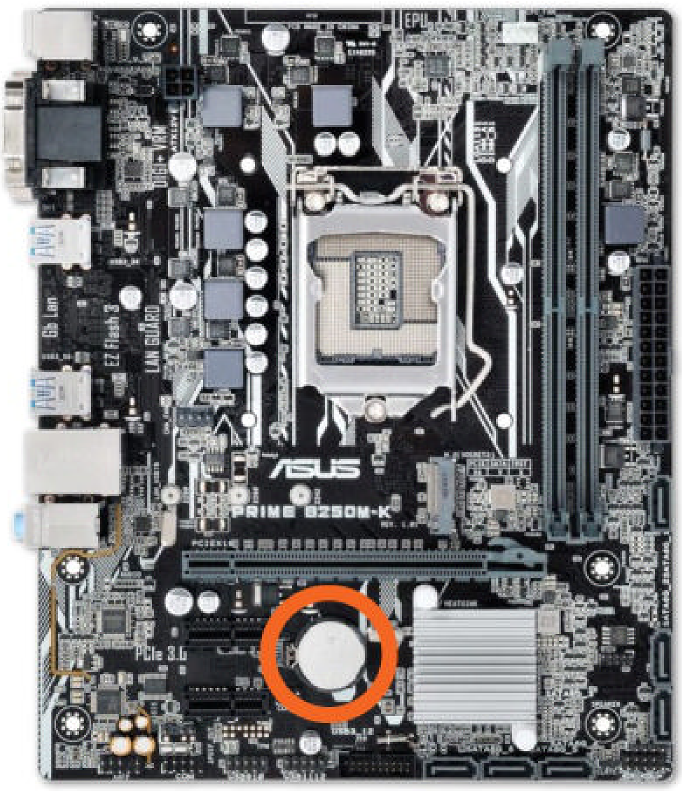
I've finally decided to try installing an SSD in my PC, following your SSD feature in the October 2022 issue. However, I have some questions. First, how do I make a list of all the programs installed on my PC so I can reinstall them easily on my new drive? Is there a listing utility, or will I have to resort to pen and paper?

I've read online that I should do a clean install, but what about my Windows settings? Finally, would copying Thunderbird's 'xxxxx.default' directory to the new drive keep all my calendars, emails, and contacts intact?

— Alan Brown

THE DOCTOR RESPONDS: You can view a list of your apps by clicking Settings followed by Apps, then 'Apps & features', but Windows doesn't provide an easy way to print it. Thankfully, NirSoft's free UninstallView tool can help. Download the program from (tinyurl.com/5n6k6fh2), launch it, then press Control (Ctrl)+A to select all listed apps. Now open the File menu and choose Save Selected Items. Type a name for the file, then click Save to create a text file containing a list of all installed apps.

Your Windows 10 or 11 settings should be automatically synced via your Microsoft account. Click Start followed by Accounts and then 'Sync your settings', and then ensure the 'Sync settings' switch is in the On position (along with the various switches below it).



If your PC is forgetting its BIOS settings, replace this battery.

As for your Thunderbird question, the short answer is yes, copying this directory will work. Good luck, and enjoy your new SSD!

Unresponsive File Explorer

Something weird is happening in Windows. I can drag, drop and double-click files as usual, but as soon as I right-click a file or folder, File Explorer becomes unresponsive. How do I fix this? **— William Erickson**

THE DOCTOR RESPONDS: The culprit is probably a piece of third-party software that has added a shell extension to the right-click context menu in Windows. To locate it, we recommend downloading the free ShellExView tool (tinyurl.com/35cwcypy) from the ever-reliable NirSoft.

Once installed, launch the program then choose Options followed by 'Filter by Extension Type'. Click 'Context Menu' so it's the only entry that's highlighted, then click OK. Now click the Company column header, which sorts the entries so that those from developers other than Microsoft are grouped together. These are marked in pink.

Canon's MG6150 doesn't offer AirPrint, but can print directly from memory cards.

Next, hold down the Shift key while clicking on the first and last pink entry to select them all. Right-click the selection and choose Disable Selected Items, clicking Yes when prompted. Now choose Options, Restart Explorer (again, click Yes when prompted). Try right-clicking, and if the problem has gone away, you know one of the entries you've disabled is responsible.

From here, re-enable entries one at a time, restarting File Explorer after each one to see if the problem reappears. Once you've identified the culprit, leave its shell extension disabled or uninstall the program.

Memory Stick Madness

I've got a 32GB USB memory stick that I've had for several years and has always worked well. Recently, I tried to copy a 10GB video file to it, but Windows 10 told me there wasn't enough room. I checked and there was well over 20GB free. I know the stick has the advertised 32GB capacity because in the past I have copied nearly 30GB of files to it. I was able to copy other video files to it without any problems, but not this large one. Any idea what's going on? **— Seb Freeman**

THE DOCTOR RESPONDS: Yes! When you bought your stick, it was probably formatted with the FAT32 file system. This is common, because FAT32 is compatible with a diverse range of devices, from Windows PCs to in-car stereos. However, for trivial historical reasons, FAT32 imposes a 4GB size limit on individual files. So, while you could copy several 4GB files to your stick without complaint, it would refuse to hold even a single 5GB file.

So that's probably the cause of your problem. The solution is to format the stick using a different file system. Modern Windows PCs use the NTFS file system, which removes almost all practical limits on file and partition size, but it might create compatibility problems with devices that don't run Windows. A much better file system for memory sticks is exFAT, which offers excellent compatibility but is a fraction slower than NTFS.

Formatting a memory stick is quick and easy, but bear in mind that it erases the contents, so make sure you copy anything you need from it first. Then, in File Explorer, right-click the memory stick and choose Format. Next, in the Format box, open the 'File system' dropdown menu and choose exFAT. Finally, tick the Quick Format box, then click Start.

And, on the topic of USB memory sticks, why not check out our feature on page 42 of the previous issue (February 2023) for loads of ideas on how to make the best use out of these little devices, which we all have hanging around in our drawers somewhere.

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ULTRA COMPACT 4070 Ti GAMING PC

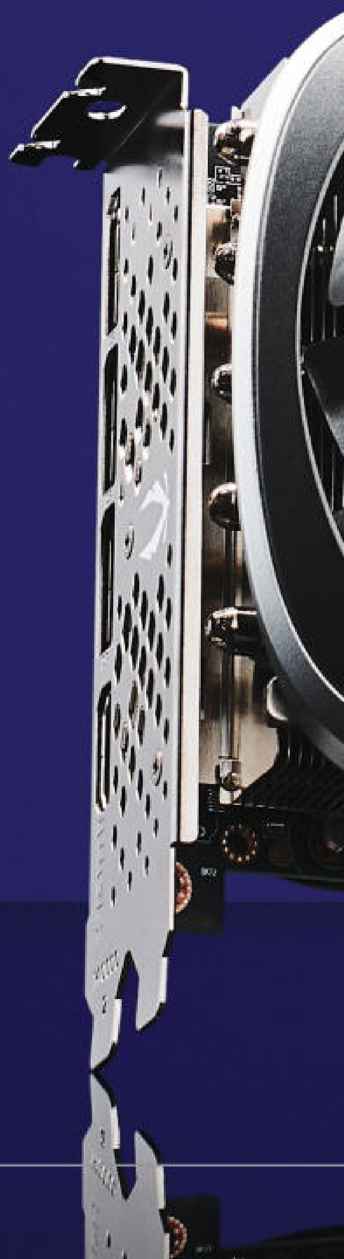
What happens when you take Nvidia's latest RTX 40 series GPU, Intel's hottest new CPU, and squeeze them into a tiny NUC 13 Extreme case? As **Sam Lewis** finds out, this compact chassis packs some punch...

GIVEN THE troubles we had getting last month's RTX 4080 build to work, we crossed our fingers for an easier build this time around. The issue is, small form factors don't often go hand in hand with easy building. Fortunately, we got our hands on Intel's latest NUC 13 Extreme kit and, as small form factor machines go, these are as user-friendly as things get. However, this model has changed a lot since we last had our hands on its predecessor, the NUC 12 Extreme. It's grown in size but maintains a sleek and subtle appearance to disguise the power that lurks beneath.

Our goal is to create a machine that does it all—offering overall power and an excellent gaming performance to make the consoles look weak, but that also works efficiently for productivity, design work, and editing. Not asking for much, are we!? The Intel NUC 13 Extreme gives us the platform to do this. Our kit was provided with an Intel Core i9-13900K, 32GB of Kingston Fury Impact DDR5 RAM, and a 1TB Kingston Fury Renegade SSD. A tasty set of components, but the only thing we are keeping is the powerhouse i9-13900K. There's nothing wrong with the RAM or SSD, but we're future-proofing this system with some more powerful parts.

Our main showpiece is, of course, our Zotac Gaming RTX 4070 Ti Trinity OC 12GB GPU, which wasn't the easiest to obtain. The limiting factor was, you guessed it, the GPU clearance. We had 313mm to play with, yet a lot of cards we researched were longer than that threshold. This card is 306.8mm, so on paper, it physically fits, while its recommended power supply is 750W, the same as included in the NUC 13 Extreme.

There are more powerful cards that would fit, but most of them require at least an 850W PSU or greater. For us, the sweet spot is an RTX 4070 Ti, so let's see what we can get out of this monstrous machine.

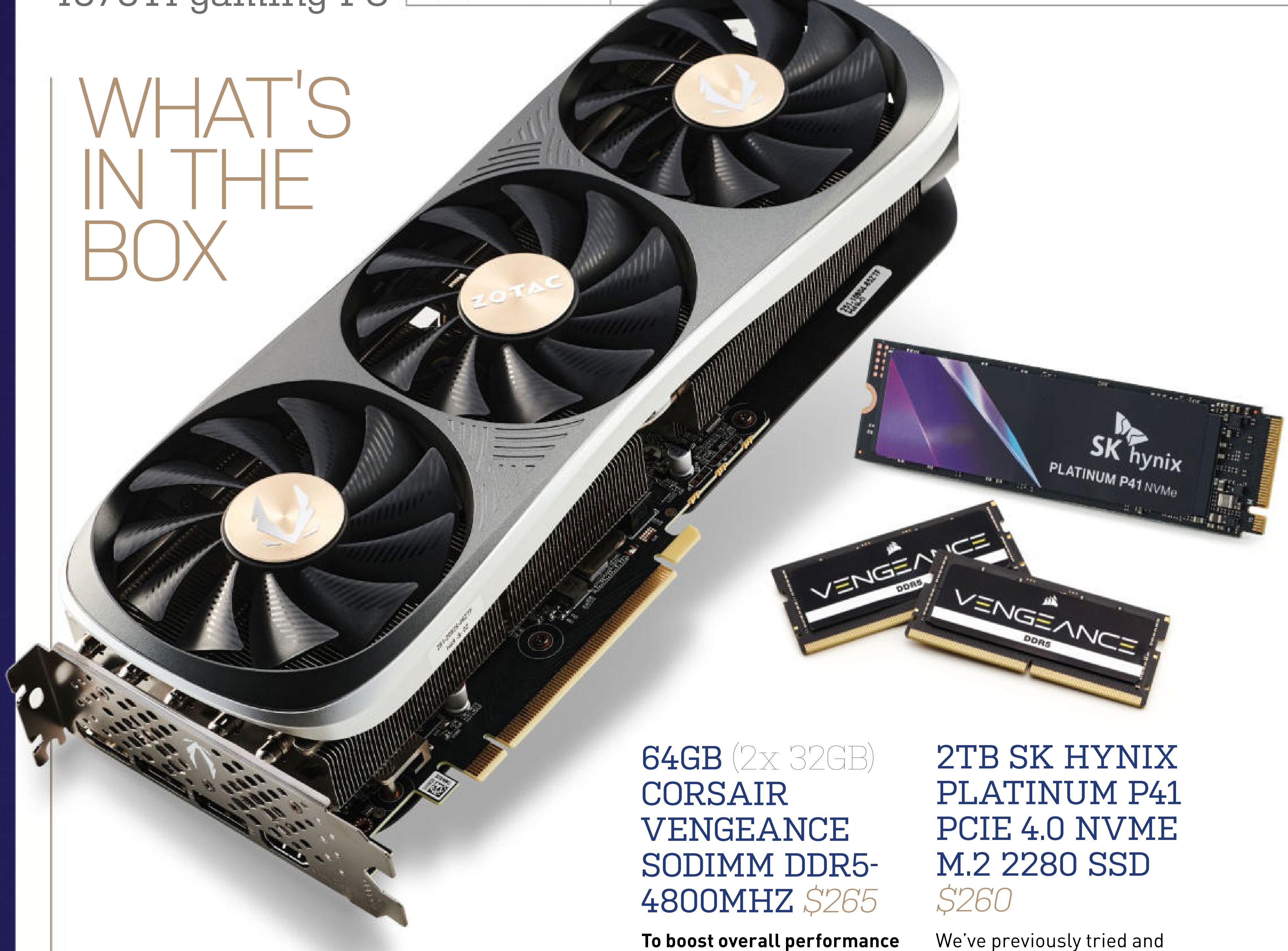


INGREDIENTS

PART		PRICE
Case	Intel NUC 13 Extreme Kit, NUC13RNGi9, w/ Intel Core i9-13900K CPU	$1,599
GPU	ZOTAC GAMING GeForce RTX 4070Ti Trinity OC 12GB	$850
Memory	64GB (2x 32GB) Corsair Vengeance SODIMM DDR5-4800MHz	$265
SSD	2TB SK Hynix Platinum P41 PCIe 4.0 NVMe SSD	$260
OS	Windows 11 Home 64-bit OEM	$32
TOTAL		$3,006

PRICES CORRECT AT THE TIME OF PRINTING

WHAT'S IN THE BOX



ZOTAC GAMING GEFORCE RTX 4070 TI TRINITY OC 12GB $850

We all know that essentially, this is a rebadged RTX 4080 12GB. It may not offer the best value in Nvidia's 2023 lineup, but it's still a powerful piece of kit.

Currently, it's the least powerful 40 series card, sitting below the RTX 4080 and RTX 4090, but that shouldn't take anything away from this card. It still offers great performance and this specific model only needs a 750W PSU.

The issues come down to the pricing. We're currently in a world where a powerful GPU that doesn't cost over $1,000 is a relative bargain, and that's a scary state of affairs. However, if you want to get your hands on a 40-series card and its resulting power, efficiency and features, then this is the card to get.

This Zotac Gaming GeForce RTX 4070 Ti Trinity OC comes with 12GB of GDDR6X, is powered by the NVIDIA Ada Lovelace architecture, features DLSS 3.0 technology, and is great for ray-traced games. It's also not as loud as its older competitor. It's just about the most powerful GPU we can fit into our Intel NUC 13 Extreme—at least on the Nvidia side of things, that is!

www.zotacstore.com

64GB (2x 32GB) CORSAIR VENGEANCE SODIMM DDR5-4800MHZ $265

To boost overall performance and improve longevity in this machine, we've swapped out the 32GB of Kingston Fury Impact KF548S38IBK2-32 SODIMM RAM for 64GB of Corsair's Vengeance SODIMM DDR5 RAM. They both boast the same 4800MHz speeds, yet we are doubling our capacity here with Corsair's offering. We've become familiar with the Corsair Vengeance lineup of memory over the years and they've been a dependable choice for many rigs we've put together.

Of course, it's not common for us to use the SODIMM format typically found in laptops, but we needed it for the Intel NUC 13 Extreme, so we looked to Corsair for a RAM kit. Out of the box, it's tuned for maximum speed, meaning we don't have to go into the BIOS to get the most out of our memory.

www.corsair.com

2TB SK HYNIX PLATINUM P41 PCIE 4.0 NVME M.2 2280 SSD $260

We've previously tried and tested the SK Hynix Platinum P41 with great success at *Maximum PC* as it provides reliable snappy speeds in prolonged testing. In our most recent build, we had our hands on the 1TB model, but we're switching things up here, and like the RAM, we're doubling our capacity—2TB should provide plenty of room for a great arsenal of games and applications.

If you're working on large productivity-based projects, fear not, as there are two further M.2 slots in the Intel NUC 13 Extreme to expand storage. This Platinum P41 offers read and write speeds of up to 7,000MB/s and 6,500MB/s, which is more than enough for file transfers and load times. Paired with the i9-13900K, this machine should be blisteringly fast in processing tasks.

www.ssd.skhynix.com

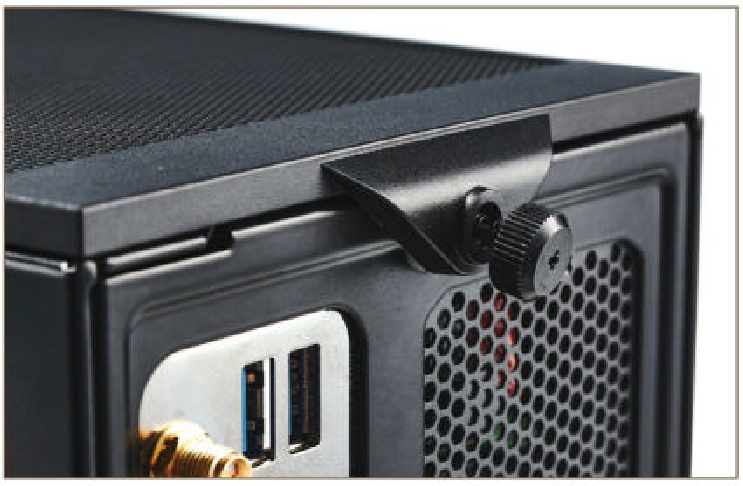
CRACKING INTO THE CASE

Is it a petite powerhouse, or a diminutive danger?

LENGTH OF TIME: **1-2 HOURS**
LEVEL OF DIFFICULTY: **MEDIUM**

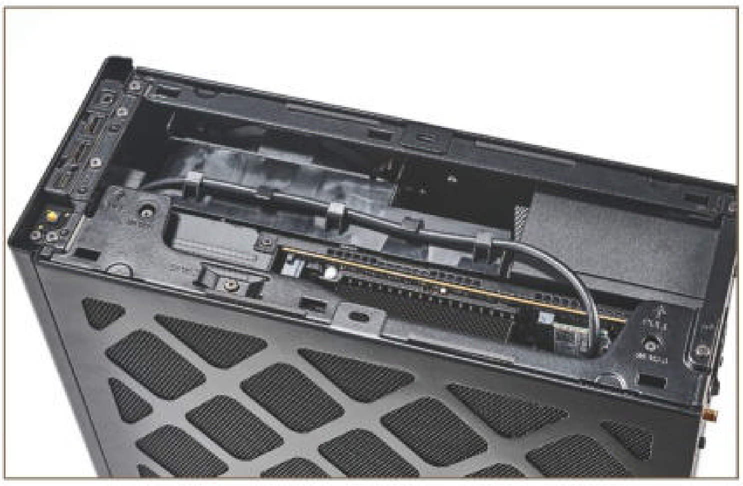
1 TROUBLING BEGINNINGS

THERE IS ONE COMMON—and almost unavoidable—issue with small form factor builds. They can be fiddly, which is just the way it goes when the chassis is this compact. Intel has ramped up the scale, but that doesn't necessarily mean this will be a walk in the park. To see what we're working with, we need to get started by opening the top of the case. This involves a heavily loaded spring thumb screw on the back of the case. Gently, and we mean gently, loosen this screw and set it aside somewhere safe. You may be wondering why we've emphasized being gentle with this heavily loaded spring thumb screw? Well, we may or may not have spent around five to ten minutes searching for it as it pinged straight off initially. We'll leave that for you to figure out.



2 OFF COMES THE TOP

NOW THAT YOU HAVE the screw loosened—and, hopefully, haven't wasted too much time looking for it on the floor—you can prize the top panel off of the Intel NUC. To do this, you'll need to slowly slide the top panel backward and then lift it upward. Place this aside, preferably next to the thumbscrew you've just taken off—it's always advisable to keep all of these parts together as builds can get messy quickly. Once this is off, we can get a first glimpse into the machine. Along the top, you'll see the USB header cable that runs across from the I/O shield to the motherboard. We'll need to come back to this later so it's worth noting. You can also see the CPU fan, a heatsink chamber, and also the compact SFX 750W PSU powering this NUC 13 Extreme.



3

EXHIBIT SIDE PANEL A

SO THE TOP'S OFF and now we need to access the side, starting with the front. Thankfully, there are no hidden screws here. In fact, so far, this isn't nearly as bad to strip down as we initially feared. To remove the side panel, pull back from the top lip and lift upwards, and it should ease off. Put it somewhere safe, as with the other parts, you don't want to scratch or damage your case. With the side panel off, we can see a large RTX 4070 Ti-sized hole at the bottom. Above that, is the Intel NUC compartment where all the wizardry takes place. Here, we can see the rest of the heatsink, CPU fan, and now our DIMM slots containing the Kingston DDR5 sticks supplied by Intel.

4

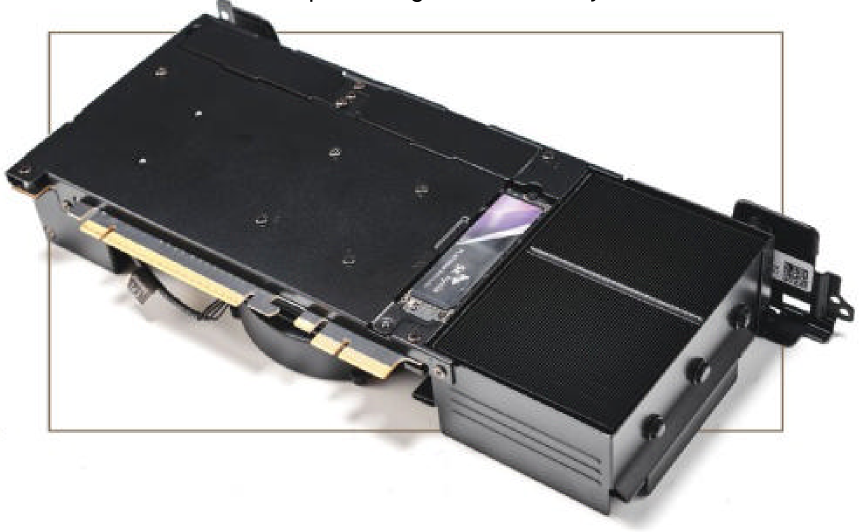
EXHIBIT SIDE PANEL B

FOR THIS NEXT STEP, we will do the same again, just on the other side, which seems pretty simple. Grabbing the top of the side panel, pull it back slightly and lift it upward to take it off. Around this side, we can see the back of our SFX 750W PSU and the two case fans. As you may have noticed, we've taken out the hard drive cage that sat towards the bottom of the case on the previous step. Because we're only using one M.2 SSD, this cage was unnecessary and we need as much space as possible to make the GPU installation less of a stress.

7

1, 2 OR 3?

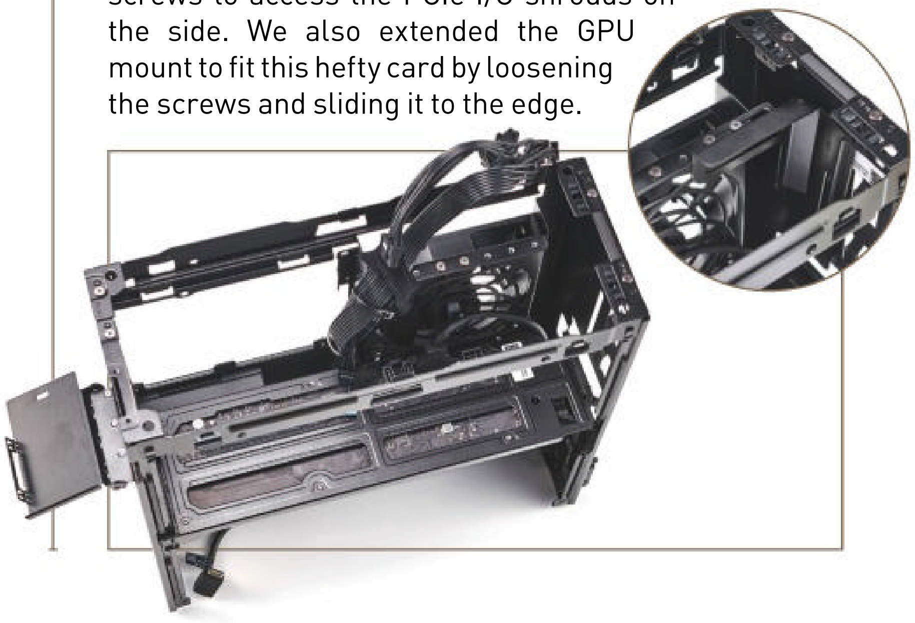
STORAGE OPTIONS on the Intel NUC 13 Extreme are plentiful, or at least they were before we took out the HDD cage. Regardless, there are still three M.2 slots available, so we just need to flip over the NUC compartment to gain access to them. When we say flip, take that with a pinch of salt—we actually mean once you've carefully turned it over, you'll see the three slots, two horizontal and one vertical. Annoyingly, these aren't numbered but the vertical is the primary, the one closest to that is the secondary and the one in the corner is the tertiary slot. Using a small screwdriver, remove the M.2 screw and take off the heatsink cover of the primary slot. Our kit came with a Kingston pre-existing kit, so we had to remove that, but if you are using a bare-bones kit then take your SSD, place it in the slot-end first, rest the heatsink cover on top, and tighten securely.



8

UPSIDE DOWN

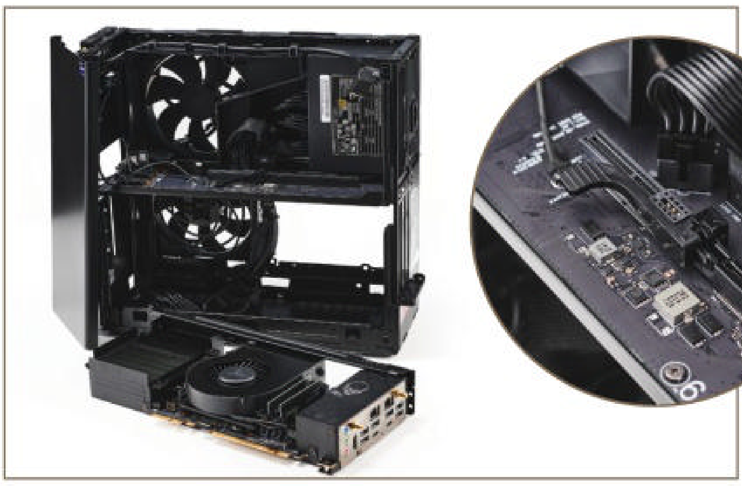
AS WE ONLY HAVE three new components to add to the Intel NUC 13 Extreme kit, we've saved the best for last, our GPU. Finding a graphics card within the 40 series Nvidia lineup that could run with the 750W SFX PSU inside the NUC and fit within the tight GPU clearance wasn't easy. Yet the Zotac Gaming GeForce RTX 4070 Ti Trinity OC 12GB should be the perfect card, and the party piece of this build. To gain access, turn the case upside down and pop off the bottom panel. With the case fans facing away from you, remove the two closest screws on each side and the bottom edge should come loose, making installing the GPU easier. You can remove some screws to access the PCIe I/O shrouds on the side. We also extended the GPU mount to fit this hefty card by loosening the screws and sliding it to the edge.



5

NUC COMPARTMENT

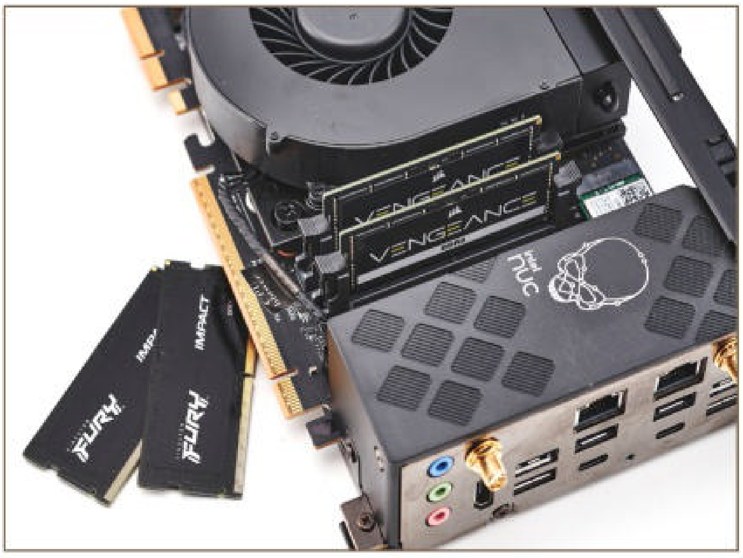
WE CAN NOW TURN our attention to the top of the case. The Intel NUC 13 Extreme is split into segments, the bottom gap leaves space for the GPU and the top houses everything else—CPU, RAM, SSD, and motherboard—so we need to release it from the case. To do this, we need to remove three screws, one on the backside of the case on the I/O shield and the other two on the top. Make sure that the CPU/heatsink is closest to you with the ‘pull arrows’ facing away from you. Underneath the right arrow, there is a screw—loosen and remove the one to the right of that, then remove the similar screw on the other side. Now unplug the USB header cable and look under the compartment for the PCIe release lever. Lifting it should free the NUC compartment, now wiggle it free.



6

HONEY I SHRUNK THE RAM

FINALLY, WE'VE separated the mainframe from the NUC's chassis. Our first port of call is to add in our 64GB of SODIMM DDR5 Corsair Vengeance RAM. Quite the mouthful, oh and did we mention it runs at 4,800MHz? Anyway, we need to take the pre-existing Kingston RAM out first. The smaller form factor doesn't change the removal or installation process here. Simply press down on the SODIMM slot clips and this will release the RAM, then just lift it out of the slots. With the SODIMM clips still open, take the new RAM, align the notch on the RAM with the slot and push in evenly. You'll hear a satisfying click to signify that you've successfully installed it.



9

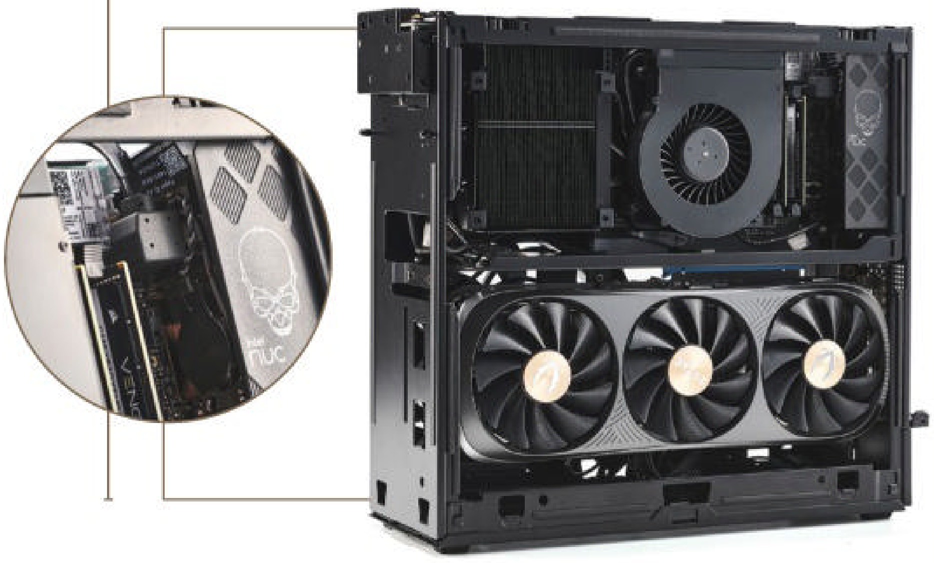
SHOWSTOPPER

NOW WE'VE MADE some space, it's time to add the major grunt for this mini-monster PC. Before adding it, make sure the PCIe clip is open and also that the GPU PCIe shrouds have been removed for the GPU's I/O ports. Align the GPU with the slot and, like the RAM, push it down into the slot until you hear a satisfying click. Now this is in, we need to screw the GPU onto the case where the shrouds are, then slide the GPU mount across to hold the graphics card firmly in place. With the mighty card ready, take the edge of the case we removed earlier and tighten this back in place, along with the shroud cover too. Then pop on the bottom cover once more.

10

STICK IT IN REVERSE

THE FINAL THING to do is re-install the NUC compartment containing the CPU, motherboard, SSD, and RAM. Having removed it in the first place, we need to do all of that in reverse. Make sure the PCIe clip for this compartment is open, line up the port with the slot and click that into place. Insert the NUC compartment back into the case and add the two screws on the top and one at the back to tighten the chassis and compartment together. Once in place, we can re-attach the USB cable to the motherboard and our NUC 13 Extreme is ready to go! We just need to slide the panels back into position and replace the top with that dreaded spring-loaded thumb screw. Though the NUC 13 is compact, it's designed in a way that makes taking it apart simple and efficient.



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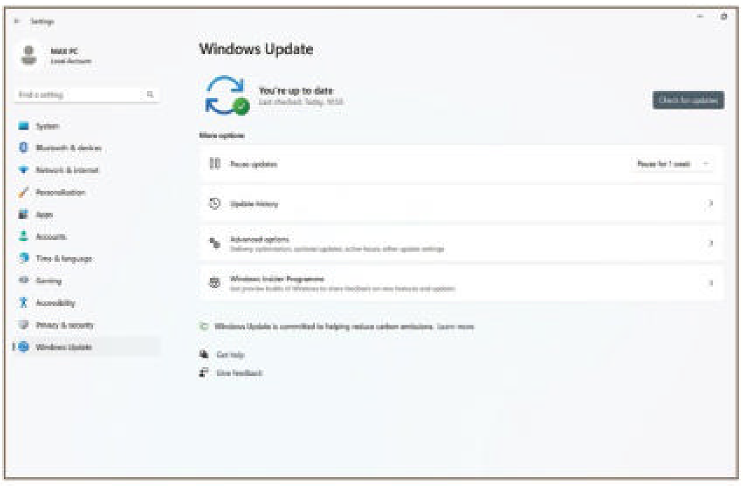
11 OS UPDATE

UNLIKE THE COMPLETELY FRESH BUILDS we regularly do, this time around we don't need to install Windows 11 or necessarily install a new BIOS update, at least not with our specific configuration anyway. Although we're excited to dive straight into our new PC, we have to slam on the brakes and make sure it's running to its maximum potential first. We usually kick things off by performing a Windows 11 update to ensure minimal bugs or potential mishaps with the system, so that's what we'll do here. We head over to settings and all the way at the bottom of the left-hand side we find the 'Windows System Update' option. While on this page, we can download any updates available, so we find 'advanced options' and then 'optional updates' to check for any.

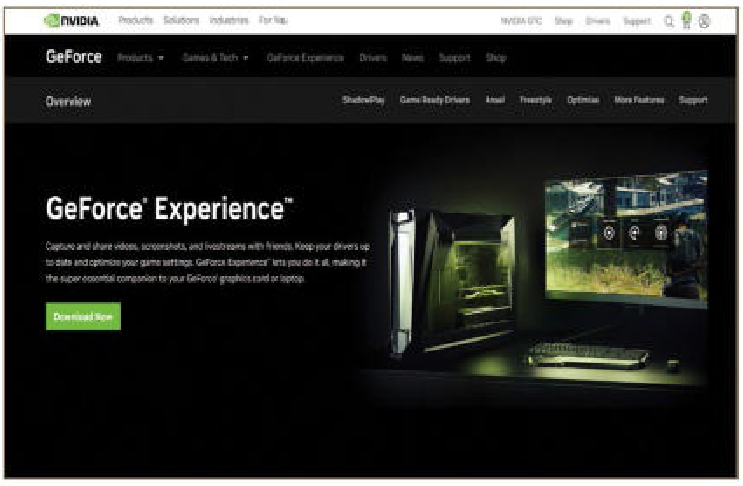

Settings
System
Bluetooth & devices
Network & internet
Personalisation
Apps
Accounts
Time & language
Gaming
Accessibility
Privacy & security
Windows Update
Windows Update
Check for updates
More options
Pause updates
Update history
Advanced options
Windows Insider Programme
Get help
Give feedback

You're up to date

12 GPU UPDATE

JUST LIKE WE NEED to make sure the system as a whole is running smoothly and efficiently, we also need to run the same checks over our sparkly new GPU. As this is an Nvidia card, of course, we need to download and install the latest drivers from the company's official website. Head over to the Nvidia website (www.nvidia.com) and find the landing page for the GeForce Experience application, then download that.

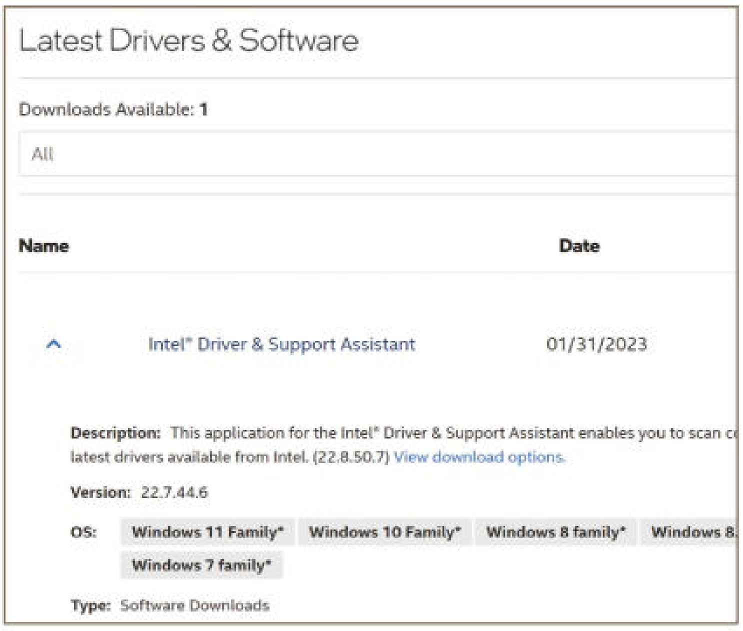
Once it's downloaded, click through to the drivers section, click 'check now' and install the latest version possible. Follow the on-screen instructions and give your system a reboot once it has been installed. Now your GPU should be ready for the abundance of games it will have to run in the not-so-distant future.


NVIDIA
GeForce
Products
Games & Tech
GeForce Experience
Drivers
News
Support
Shop
Overview
ShadowPlay
Game Ready Drivers
Ansel
Freestyle
Optimize
More Features
Support
GeForce Experience
Download Now

Capture and share videos, screenshots, and livestreams with friends. Keep your drivers up to date and optimize your game settings. GeForce Experience lets you do it all, making it the super essential companion to your GeForce graphics card or laptop.

13 INTEL DRIVERS

WE'RE TRYING TO AVOID sounding like a broken record, but here we are with yet another driver installation step, this time for your Intel drivers. Head over to the official Intel website (www.intel.com) and find the installation page for the Intel Driver & Support Assistant. Follow the installation wizard and launch the program, this will open up a web page where you can scan through your system to see whether your Wi-Fi, Bluetooth, and Intel Graphic Drivers are up to date. If there are any available, install them and restart your system afterwards.


Latest Drivers & Software

Downloads Available: 1

All

Name	Date
Intel® Driver & Support Assistant	01/31/2023

Description: This application for the Intel® Driver & Support Assistant enables you to scan c
latest drivers available from Intel. (22.8.50.7) View download options.

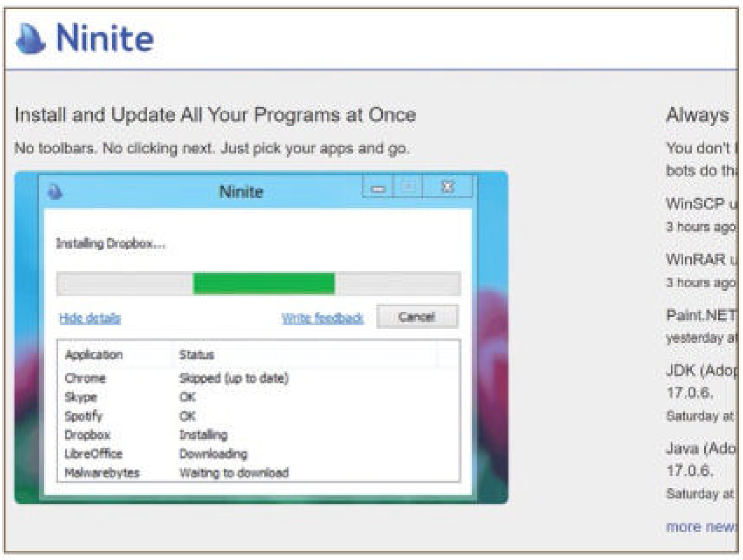
Version: 22.7.44.6

OS: Windows 11 Family* | Windows 10 Family* | Windows 8 family* | Windows 8. | Windows 7 family*

Type: Software Downloads

14 EVERYTHING ELSE (ISH)

WITH ALL OF THE NECESSARY DRIVERS and updates performed, we can get to the fun stuff by heading to one of our favorite all-in-one application solutions, Ninite (www.ninite.com). This site has all of the main apps you'll need to get going with your new rig. From browsers, game stores, security applications, editing suites, utilities, music programs, and more, Ninite has a huge range of important pieces of software. Go through the list, tick which ones you want, hit the 'get your ninite' button and then let the magic happen. This will download the latest versions of all the apps you've chosen and will also keep them up to date for you. Not bad!


Ninite
Ninite
Hide details
Write feedback
Cancel

Install and Update All Your Programs at Once

No toolbars. No clicking next. Just pick your apps and go.

Installing Dropbox...

Application	Status
Chrome	Skipped (up to date)
Skype	OK
Spotify	OK
Dropbox	Installing
LibreOffice	Downloading
Malwarebytes	Waiting to download

Always
You don't
bots do th
WinSCP u
3 hours ago
WinRAR u
3 hours ago
Paint.NET
yesterday a
JDK (Adop
17.0.6.
Saturday at
Java (Ado
17.0.6.
Saturday at
more new

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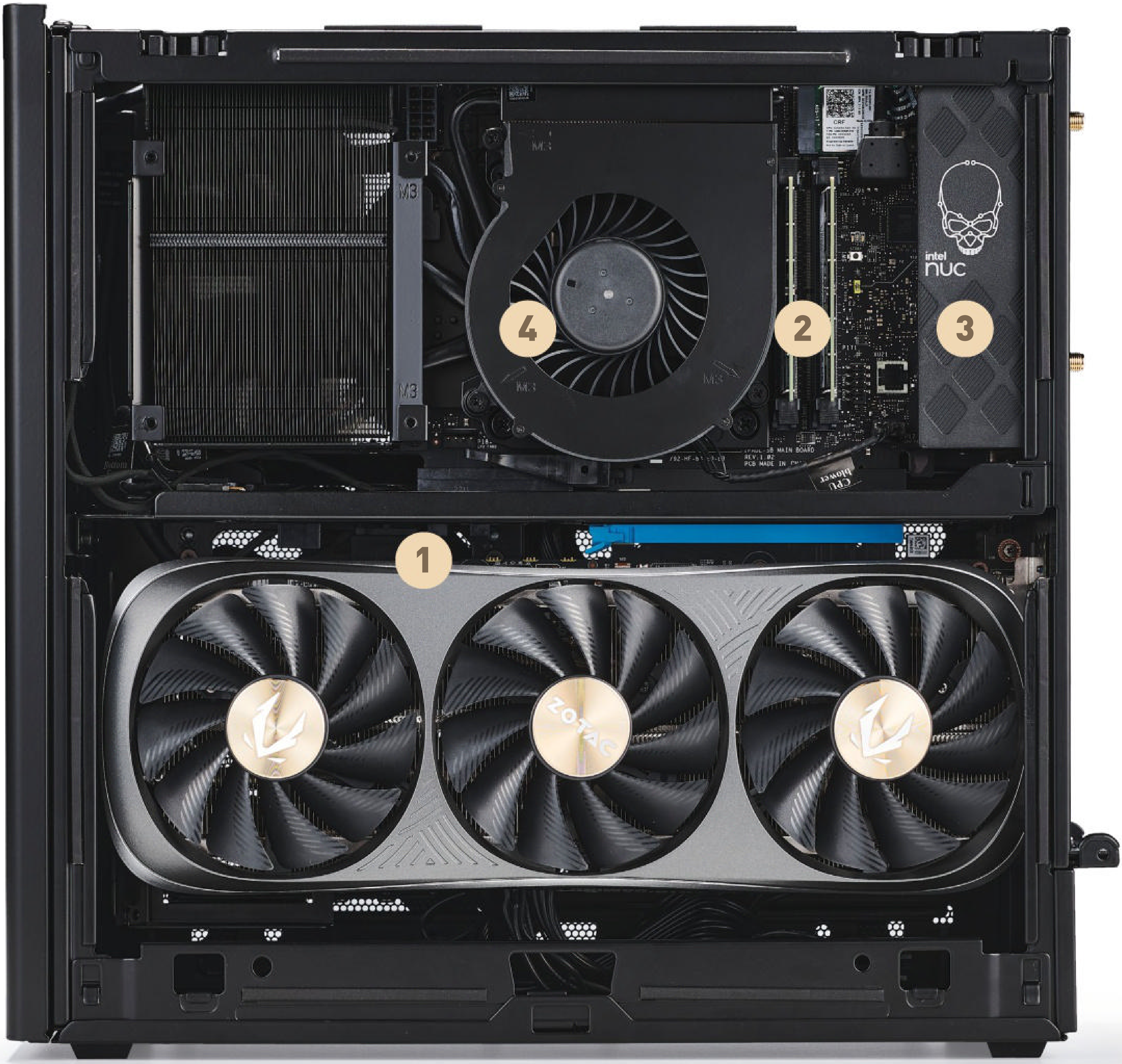
GREAT THINGS COME IN

① It's a tight squeeze, to say the least, but here we have it. An Intel NUC 13 with a helping hand from an RTX 4070 Ti OC card, this is one mean mini machine.

② There are only two SODIMM slots available here, so take your time choosing which RAM to go for, especially if you are thinking of future-proofing in the long-term.

③ Here it is, the infamous Intel skull. Thankfully, this time around, it's hidden inside the case instead of being on the face, as it was on the previous Intel NUC 12.

④ Underneath this cooler lurks some serious brain power, Intel's Core i9-13900K. There's not really much more we could ask for in terms of CPU. It's a beast.



SMALL PACKAGES

WHEN YOU THINK of a PC setup, you may typically envisage a desktop ATX machine paired with a monitor, keyboard, and mouse. Yet not all PCs have the same uses, and this Intel NUC is a great example of this. Due to its smaller footprint, it offers greater versatility, meaning you could set it up in places where you wouldn't usually put a desktop.

For example, you could use this NUC 13 Extreme as a games console alternative, which we will touch on later, in a living room or a gaming room scenario. Granted, it's far more expensive than a games console, yet it will provide the best gaming experience in that environment while also keeping the games console aesthetic, and still double up as a kick-ass PC! With a smaller form factor, the main drawback is the lack of performance due to space-saving, but our build here with the Intel NUC 13 Extreme proves that you can use the latest cutting-edge performance parts within a subtle mini system.

So then, how did this build go? Usually the phrase 'small form factor' can strike fear into the hearts of any PC builder, but thankfully, with the way this Intel NUC has been designed, this wasn't an awkward journey. Compared with the previous Intel NUC 12, it's far easier to work with as you can remove much more of the exterior than the latter.

These NUC systems are more than just small form factor cases, they are fully-fledged kits that can also be upgraded. Our press kit model specifically came with the best CPU choice, the Intel Core i9-13900K, 32GB of Kingston DDR5 RAM, and a 1TB Kingston SSD. There are various configurations available but all you need for what we achieved in this build is the bare-bones kit. This comes solely with the CPU and that's what we have priced in our spec list.

With this kit, we managed to achieve everything we set out to do. Despite size not being on its side, this PC can do it all. On paper this was evident, we have an absolute powerhouse of a CPU with the 13900K paired with a Zotac RTX 4070 Ti OC card, 64GB of DDR5 SODIMM RAM, and a snappy SK Hynix Platinum P41 SSD. These are blisteringly fast components and, working within the constraints of the NUC, this was one of the best configurations we could choose. The only potential issue we were concerned about was the possibility that the machine would overheat. However, when running our tests and gaming at 4K, this machine never got too hot. Of course, in a full ATX case, with a liquid cooling solution, you'll get much better results, but that's just a given when working at this size—it's all swings and roundabouts.

The same can be said for the cost. At a little over the $3,000 mark, this is a pricey rig, and for the same money you could certainly get greater performance elsewhere. However, performance isn't the be-all and end-all of a PC. This NUC offers an alternative to a conventional PC with plenty of grunt, future-proofing, and the ability to upgrade down the line, all within a discrete and well-built chassis.

MINI MASTERCLASS

In terms of performance, this mini masterclass was everything we could have hoped for. You can game on this thing at 4K with frame rates higher than 60fps for a smooth experience. For the best results though, we suggest playing in QHD resolution to achieve a higher refresh rate, but the option for 4K is there and feasible. Pair this machine with a controller and a 4K 120Hz TV and you'll have a brilliant couch gaming rig at your disposal. Our Zotac Gaming GeForce RTX 4070 Ti Trinity OC card was the perfect match for this system. An RTX 4080 or above was out of the equation due to the power needed to run both that and the resource-hungry i9 CPU. As the NUC was powered by a 750W SFX PSU, we found this to be the perfect combination.

Gaming performance isn't also the main point to take away from our benchmarking. As you can see, we scored highly on the Cinebench results testing both the single-core and multi-core capabilities of our Intel Core i9-13900K. The same can be said for our high read/write speeds. Although in our last build, we used the same SSD just the 1TB variant and that scored slightly better than our 2TB model. We are sure a few BIOS tweaks can alter this but regardless, transferring files and load times are super snappy. Taking everything into consideration, this is one killer gaming machine with the ability to be used either professionally or creatively too, due to the sheer amount of power hidden beneath its subtle armor.

BENCHMARKS

	ZERO-POINT	
Cinebench R23 Single-Core (Index)	1,962	2,086 (6%)
Cinebench R23 Multi-Core (Index)	18,502	21,524 (16%)
CrystalDisk QD32 Sequential Read (MB/s)	7,427	7,039 (-5%)
CrystalDisk QD32 Sequential Write (MB/s)	6,649	6,241 (-6%)
3DMark Fire Strike Extreme (Index)	31,648	26,136 (-17%)
Cyberpunk 2077 (fps)	73	61 (-16%)
Cyberpunk 2077 RTX (fps)	49	41 (-16%)
Metro Exodus (fps)	91	73 (-20%)
Metro Exodus RTX (fps)	63	49 (-22%)
Total War: Three Kingdoms (fps)	81	67 (-17%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of the RTX 4080 Gaming Machine from our February 2023 issue, featuring an AMD Ryzen 7 7700X, Nvidia Founders Edition GeForce RTX 4080 16GB, Asus ROG STRIX B650-A Gaming Wi-Fi, 32GB (2x16) of Corsair Vengeance DDR5-4800, and 1TB SK Hynix Platinum P41 PCIe 4.0 M.2 SSD. All games tested at 4K 'Ultra' graphics presets with DLSS and V-sync turned off and XMP for RAM speed turned on. No manual CPU overclocking.

GAMING WITH THE NUC 13

WITH THE SYSTEM UP and running and ticking over exactly how we wanted it to, now's the time to start loading it up with our favorite gaming applications so we can get the most out of it. As we already noted, the NUC 13 visually looks more like a console than a typical gaming PC.

The subdued aesthetics help the case fit into a variety of setups. While there's nothing particularly exciting going on with the design here, that minimalistic look means there aren't many interiors that it wouldn't suit. Now, we know looks aren't everything, but if you were to use this as an overkill console, then it would need to either sit within a TV unit or look fairly discreet in that environment.

However, the PC isn't the only important thing you'll need to get going, of course. To make the most of your new mighty small powerhouse, there is a whole range of applications and peripherals you can add to the mix to take this thing to the next level.

AOC AGON AG275QX 27-INCH $350

If you're specifically choosing a display based on this Intel NUC 13 Extreme RTX 4070 Ti build, there are a few things to look out for. In our benchmarking, we suggested that QHD would be a better option than outright 4K gaming so that would be our first choice.

With monitors usually located on your desk, the difference between QHD and 4K won't be as noticeable as the difference in frames per second. QHD means that detail will be great and you'll be able to crank up the in-game settings more than if you were running at 4K.

There's no point playing games at higher frame rates if your monitor can't match it, so we'd recommend a display with at least a 144Hz refresh rate and a response time of 1ms, so input delay will be at a minimum. Use a DisplayPort cable from the GPU to your display.

For out-and-out performance, the best color range, and the highest refresh rates and lowest response times, the AOC Agon AG275QX is a great shout. It's a 1440p 27in QHD monitor with a 1ms response time, 170Hz refresh rate, and a contrast rate of 1,000:1.
www.aoc.com

LG C2 48-INCH CLASS 4K OLED EVO W/ THINQ AI $950

If you're after something larger or don't have the space for a designated office or gaming room, then you can go down the gaming TV route.

Here, it makes more sense to opt for a 4K resolution, as this means you can use your PC as a home media center as well as a gaming rig. You can change the resolution within your PC display settings down from 4K to QHD to gain more performance if required.

Much like the monitor situation, Hz is important and 4K TVs running at 120Hz are much more available than they used to be. There are so many options but, of course, they offer more than a typical monitor. TV functionality is the key difference and also the built-in speakers are far more detailed—many monitors don't even come with audio.

LG's C2 range of TVs offer a great OLED panel, 4K resolution, and 120Hz capabilities, which is a recipe for success when hooked up to our RTX 4070 Ti Intel NUC 13 machine. LG has been knocking it out of the park for what seems like forever when it comes to picture quality. Its OLED has rich colors, deep blacks, and a great contrast ratio.

If you want to couch game, then this LG C2 48-inch Class 4K OLED evo with ThinQ AI will make for the perfect addition to your setup.
www.lg.com

© LG

SCUF INSTINCT PRO *$220*

Regardless of whether you're using this for desktop or couch gaming, your controller or keyboard and mouse combo needs to match the level of your system. If you're spending lots of money on a computer such as this Intel NUC PC, then there's no point in skimping on your peripherals.

That's where the SCUF Instinct Pro comes in, taking the standard Xbox controller layout and improving on it. With lots of customization, rubberized grips, adaptive on-the-fly triggers, and back paddle buttons, it has plenty of playing options and looks the part. It's powered by AA batteries, though you can always use a USB Type-C cable instead.

www.scufgaming.com

RAZER BASILISK V3 PRO *$170*

A wireless mouse was once a luxury, but if you're planning on using a TV or projector, then you're definitely going to need one.

Here, we've chosen the Razer Basilisk V3 Pro that we recently reviewed, as it's been created with gaming in mind. It's a great-looking asymmetrical mouse with rubberized grips on either side, a clutch button (offering adaptive DPI speeds), an on-the-fly free-spinning scroll wheel, and a great glide thanks to its weight and PTFE feet.

It has lots of connectivity options, customizations in the Razer Synapse app, and wireless charging if you bundle in the Razer mouse dock pro with wireless charging puck.

www.razer.com

CORSAIR K70 PRO MINI WIRELESS *$180*

Similar to a wireless mouse, a cord-free keyboard is a necessity for living room operation, and this Corsair Mini keyboard will help keep your footprint small. At 60 percent size, you lose some convenience compared with a full keyboard, yet you also benefit from the smaller size.

This keyboard is no slouch, with Cherry MX Red switches, a durable build quality, detachable cable, Corsair's Slipstream wireless technology, and hot-swappable keys. It's great for gaming and, with its high polling speeds, has a lot going for it in terms of general use.

www.corsair.com

ASUS H1 PROJECTOR *$1,099*

If TVs still aren't large enough for your needs, then you can ditch the traditional display entirely and go for a projector.

Although it's the least practical option for a gaming display due to having the most input delay—you won't necessarily want to compete in eSports tournaments using a projector—it gives you the most immersive experience, perfect for cinematic games. Like the TV credentials, you'll need a projector with at least a 120Hz refresh rate to match your game's frames per second. Resolution isn't as vital when choosing a projector, as the quality will never match that of a TV or monitor. It's more about the feeling it gives you and the scale of your display.

This Asus H1 projector runs at 120Hz at a resolution of 1080p FHD, which is more than enough for a projector, and allows you to boost your FPS and crank the settings up for greater detail in your games. It also can project up to 200 inches, which is far larger than you'll usually need.

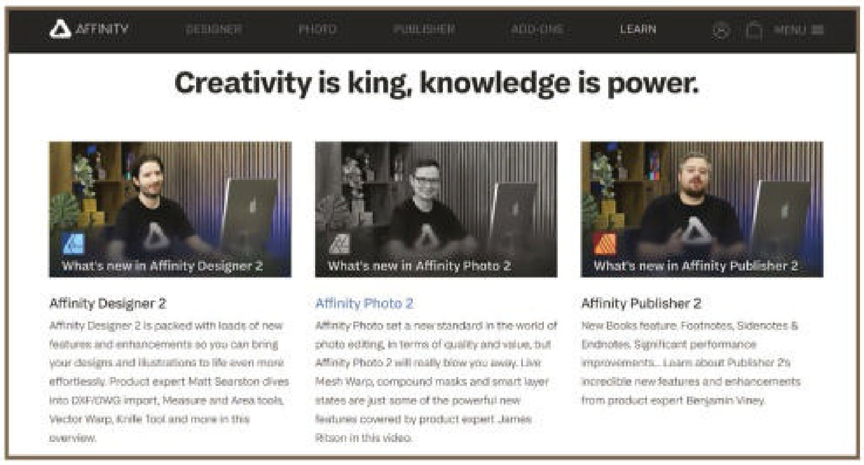
Projectors are versatile, can be installed in various different setups, and give you that nostalgic feeling you get from being at the cinema.

www.asus.com

CREATING WITH THE NUC 13

ALTHOUGH IT'S more console-sized than a regular PC, gaming isn't the only thing this Intel NUC 13 build can do. Not only can this rig run your favorite triple-A titles at high frame rates but it also doubles up as one monster workhorse. That's due to the Intel Core i9-13900K processor with a whopping 24 cores and a maximum turbo frequency of 5.8GHz. With a similar architecture to the impressive previous-gen i9-12900K, this newer iteration takes all that was great about the last flagship CPU and cranks it up even more.

It features a hybrid architecture containing performance (foreground) and efficiency (background) cores. The i9-12900K had eight of each, but the i9-13900K has eight performance cores and 16 efficiency cores. So what does that mean? This is a great chip for 3D rendering, which allows for video and photo editing, graphic design work, and other creative possibilities. The productivity chops of this Intel NUC 13 are as equally impressive as its gaming prowess, so let's see how we can put all this power to good use.


AFFINITY
DESIGNER
PHOTO
PUBLISHER
ADD-ONS
LEARN
MENU
What's new in Affinity Designer 2
What's new in Affinity Photo 2
What's new in Affinity Publisher 2

Creativity is king, knowledge is power.

Affinity Designer 2

Affinity Designer 2 is packed with loads of new features and enhancements so you can bring your designs and illustrations to life even more effortlessly. Product expert Matt Searston dives into DXF/DWG import, Measure and Area tools, Vector Warp, Knife Tool and more in this overview.

Affinity Photo 2

Affinity Photo set a new standard in the world of photo editing, in terms of quality and value, but Affinity Photo 2 will really blow you away. Live Mesh Warp, compound masks and smart layer states are just some of the powerful new features covered by product expert James Ritson in this video.

Affinity Publisher 2

New Books feature. Footnotes, Sidenotes & Endnotes. Significant performance improvements... Learn about Publisher 2's incredible new features and enhancements from product expert Benjamin Viney.

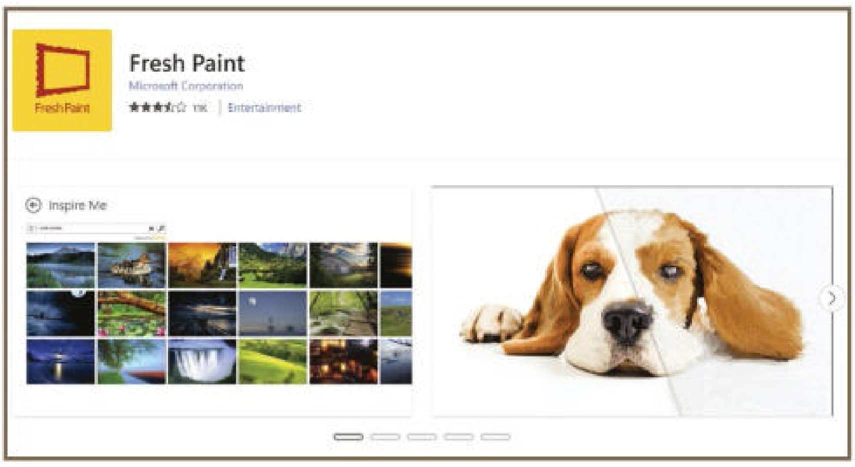
SERIF AFFINITY V2 SUITE *$170*

Software subscriptions are a pain in the backside—what ever happened to paying a one-off price for something? But with developers raking in the bucks for their subscription-based applications, they simply don't care. Take Adobe, for example, long gone are the days when you could own its Photoshop, InDesign, or Illustrator programs outright.

That's where Serif's Affinity Suite comes in. A competent alternative to Adobe, you get Affinity Designer 2, Affinity Photo 2, and Affinity Publisher 2. All of these provide a similar experience to the Adobe industry standard and are more than powerful enough to produce professional work.

The V2 applications contain refreshed UI, performance upgrades, and a better user experience. For a one-off fee of $170, you can grab this bundle of Affinity programs, keep them and get free updates until the almost inevitable V3 release.

www.affinity.serif.com



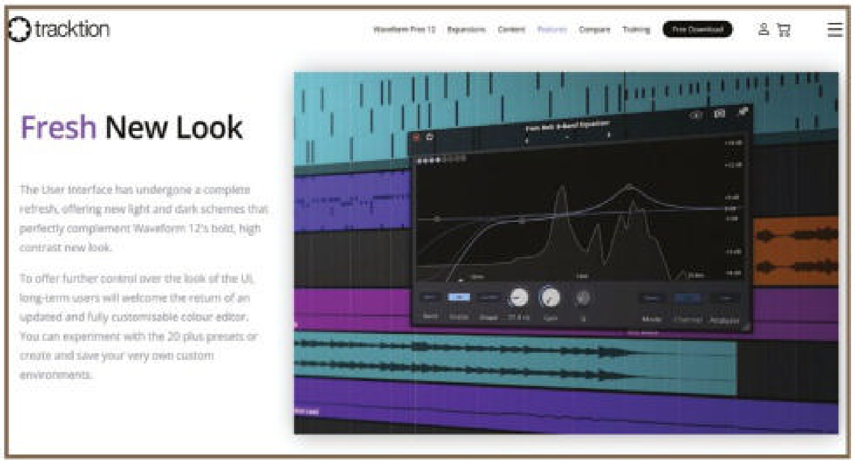
FRESH PAINT *$FREE*

Sometimes it's the apps that strip things back to basics that just seem to hit the nail on the head. Not everything has to be taken in such a commercial and serious light and that's where Microsoft's Fresh Paint comes in.

So what is it? It's a tool for all the creators out there, allowing artists of all levels of experience to sketch, draw and paint on a digital canvas. It's a simple concept, but as in the real world of art, the world is your oyster and the only real limit is your imagination.

If using your mouse is a struggle and you don't have a touchscreen display, then we recommend hooking up a graphics tablet to the Intel NUC 13. For a budget-end tablet, you can't go wrong with Wacom's One tablet. Starting at $50, it will improve your digital sketching skills at a stroke.

www.apps.microsoft.com



Fresh New Look

The User Interface has undergone a complete refresh, offering new light and dark schemes that perfectly complement Waveform 12's bold, high contrast new look.

To offer further control over the look of the UI, long-term users will welcome the return of an updated and fully customisable colour editor. You can experiment with the 20 plus presets or create and save your very own custom environments.

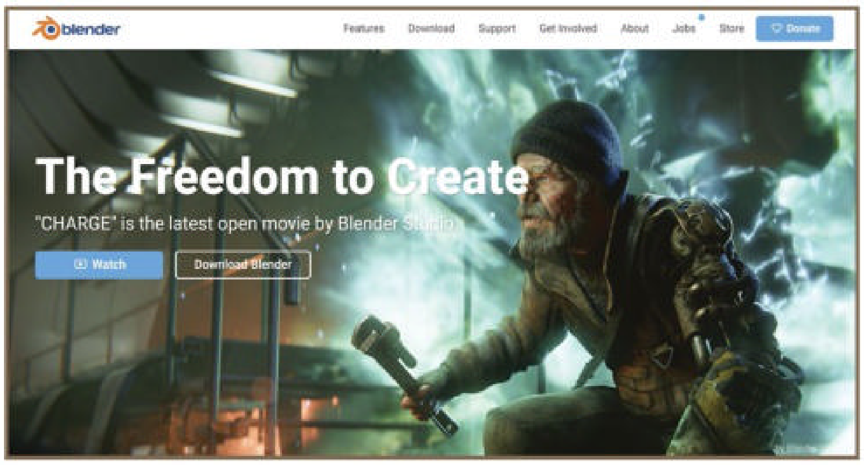
WAVEFORM FREE 12 *$FREE*

Moving away from the art and design realm of creativity and diving into the world of music creation, we're checking out Waveform Free 12—the best free Digital Audio Workstation (DAW) on the market right now. While there are lots of such free apps, if a company also produces a paid alternative, they may lack features and support, or contain a trial element. However, what you get here is a fully-fledged piece of software, which is an older version of Tracktion's premium DAW.

It comes with all the tools you need to create your own music, and while they won't necessarily be the latest versions, they are free and work across platforms. While it's a great way to try it out, Waveform Free 12 is a polished application, appealing to producers, mixers, singer/songwriters, and podcasters alike. If this is something you'd like to experience, or just want to save money, Waveform Free 12 is a great option.

www.tracktion.com

© BLENDER, AFFINITY, GIMP, MICROSOFT, TRACKTION



The Freedom to Create

"CHARGE" is the latest open movie by Blender Studio

BLENDER *$FREE*

If you're looking for a creative tool that can do it all and costs you nothing, then look no further than Blender. This open-source 3D creation suite gives the user the ability to create near enough everything under the 3D design umbrella. That includes animation, modeling, simulation, rendering, compositing, and motion tracking.

The website features all the tools you'll need for the specific 3D design work you're interested in, plus basic tutorials to get you started, active user communities for help and advice, and more. Our PC will certainly be able to handle the usage of this application, although you may need to invest in secondary storage solutions.
www.blender.org

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MANIPULATION PROGRAM
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RELEASE NOTES

GIMP *$FREE*

The best way to test the waters with design software is by trying out a free application. If you find that you never use it or it wasn't your thing, at least your wallet doesn't suffer. GIMP (the 'quirky' name stands for GNU Image Manipulation Program) is a powerful open-source image editing program that can be used as a stepping stone in the world of design, all the way to commercial-grade work.

It isn't the most polished of applications, but you can't knock its capabilities and charm. If you're looking to create graphic design work, edit images, or fancy trying your hand at being a digital illustrator, then GIMP will get the job done—and the best thing is, it's free!
www.gimp.org

STREAM DECK + *$200*

Featured in greater detail in *Centerfold* on page 50, we couldn't leave this multi-tool out of the equation.

The greatest evolution of the Stream Deck yet, this Plus variant contains a new 4-inch touch display and four new dials for even more control than the previous models and lots of customization within the application. Paired with our Intel NUC 13 Extreme setup, this will improve your workflow, productivity, and creativity no end.
www.elgato.com

BEYERDYNAMIC MMX 300 *$230*

Technically a gaming headset offering from Beyerdynamic, there's no denying that these double up as great headphones for audio creation purposes too. Audio quality is at the forefront of these headphones, which deliver a spatial sound with crisp highs and a warm punchy bass.

The quality doesn't stop there though, as the build is extremely durable and comfortable. Design-wise, they're discreet, meaning they can fit into any environment whether that's a professional office setting or on the daily commute, or just for chilling out at home. **north-america.beyerdynamic.com**

OUR FAVORITE SMALL FORM FACTOR CHASSIS

THE INTEL NUC is at the forefront of small form factor chassis, and also has the bonus of being supremely easy to build in. After all, it's more than just a case—it's a bare-bones kit that comes with most of the pieces pre-installed to save you some of the hard work. However, these cases don't come cheap, especially the top-of-the-range i9-powered Intel NUC 13 Extreme. There are far cheaper options available, including some so small that you can even mount them to the back of your monitor.

If you want to create a small form factor using a Mini-ITX or Micro-ATX, you don't have to go down the same flat-out route we did with the NUC 13 Extreme. There are plenty of other alternatives on the market with different purposes, and we've listed some of our favorites here.

COOLER MASTER MASTERCASE H100

$70

This is the cheapest offering on this list, but that doesn't take anything away from the MasterCase H100. It's fun, distinctive-looking, and has one whopping great fan taking all of the limelight at the front. That fan is a 200mm RGB unit from Cooler Master's H-Series range. Its form factor, like the rest here, is Mini-ITX and its cube-like size makes it perfect for portability, especially with a built-in handle.

Unusually, this mini box can house a full ATX PSU, which is better than the Intel NUC 13 and NZXT H1 chassis that only support SFX. Saying that, even though you can power more resource-hungry GPUs from a standard ATX power supply, you can't fit them in this box. It only has a GPU clearance of 210mm, which doesn't give you too many options to play with. Regardless, this is a great machine and is an interesting chassis to build with, and who doesn't like portability?

www.phanteks.com

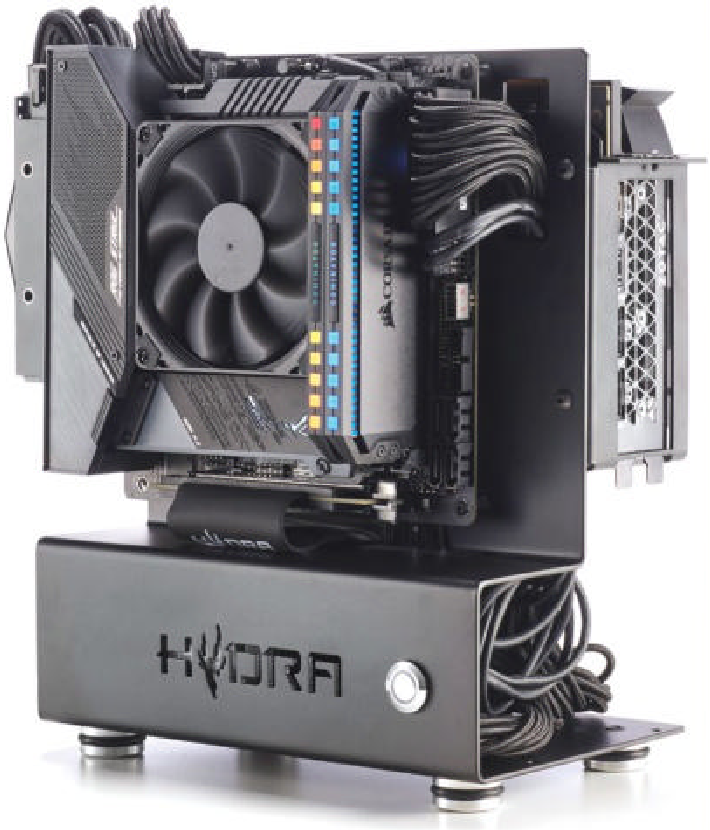
TEENAGE ENGINEERING COMPUTER-1

$195

A fun, quirky, hobbyist alternative to a conventional PC that looks like the love child of Meccano and Intel/AMD—what's not to like about this case? It arrives in a sheet metal format and you have to physically bend and construct the chassis yourself. That may sound like hard work, but from our hands-on experience with the case, it can be an enjoyable way to spend an afternoon.

The only drawback is that once you start piecing the system together, things can get rather tight inside, but that's a given with a Mini-ITX machine. Much like the Intel NUC 13, it supports an SFX PSU but the performance is held back by physical restrictions. You can only fit a dual-slot GPU up to 180 x 130 x 40mm in this machine. Yes, this thing is pretty small, but with its unique metallic design, it makes for a head-turning PC case.

teenage.engineering



NZXT H1

$400

NZXT's H1 case is much closer to the Intel NUC 13 Extreme offering than the other entrants in this list. With beautiful aesthetics that even outshine our NUC build in the looks department, the H1 has a console-like design to it— especially in its black configuration, which bears a striking resemblance to the Xbox Series X.

Much like the NUC we built with, it's more than just a case. It also comes with an SFX 750W PSU, 140mm AIO liquid cooler, Aer P140mm fan, and 92mm PWM Fan, and supports Nvidia 30 series and AMD 6000 series graphics cards. And in terms of its dimensions, it could also house our Zotac Gaming GeForce RTX 4070 Ti Trinity OC card, albeit while maxing the PSU's limits.

Overall, the NZXT case will make for a well-constructed machine, but bear in mind that you need to provide a Mini-ITX motherboard, RAM, SSD, GPU, and CPU. For the Intel NUC 13 Extreme kit, you need an SSD, RAM, and GPU, with the price difference reflecting this.

www.nzxt.com

PHANTEKS EVOLV SHIFT X $160

Another Mini-ITX case, yet this one has the ability to house a full custom loop liquid cooling system inside. Now if that isn't overkill, we don't know what is. Regardless, when we built a liquid-cooled system inside this chassis with pink coolant, it resulted in one awesome-looking and performing PC.

This system is versatile with 360° accessibility to make building easier, and you can also orientate it vertically or horizontally. It contains two tempered glass panels that allow you to see the fruits of your labor—if you've liquid-cooled your system as we did, why would you not want to stare at it?

You can even fit a GPU of up to 529mm in length, which means you could even go for an RTX 4090. As a package, this chassis provides everything you need—ease of use, plenty of compatibility, and striking looks. If you want to stray from a typical PC tower look, this does the trick.

www.phanteks.com

HYDRA MINI EXPANDED BUNDLE

$111

This is another unusual-looking chassis, to say the least, but on the plus side, there are literally no limits to building in this case. The simple design features no side panels, meaning that it isn't necessarily the best for keeping clean, but it definitely offers something different from the vast majority of small form factor systems.

Again, it's a Mini-ITX machine so that does have its limitations, but you can still create a capable system that doubles up as a piece of modernist desktop art. Constructed of 2mm thick AISI 304 (Stainless Steel), it's a sturdy chassis as well.

As the case (if you can call it that) is subtle, the components in the system become the main focus. If you have a set of fancy parts, like we did when we built using the Hydra Mini, it's a great way to show them off.

www.hydra-shop.com

BEST OF CES 2023

After a quiet 2022, the world's biggest tech show returned to normal in Las Vegas. *Guy Cocker* was on the ground to find the PC hardware that will shape 2023

GIVEN THE LAST two years of digital-only or poorly attended physical shows, it was great to see the Las Vegas Convention Center packed with new technology once again. Fighting through the accompanying throng of journalists, analysts, and industry professionals was less welcome, especially when the corridors were blocked by people inexplicably trying to claim a free skateboard but, overall, it was great to feel the buzz of the world's biggest tech show return. We left with the impression that the industry, and the PC market in particular, was in rude health, with loads to look forward to this year.

In terms of overall themes, there were some clear winners, such as Intel, AMD, and Nvidia, who all brought their latest-generation chips to laptop manufacturers eager to snap them up for this year's machines. But the winner for the tech of the show was monitors—2023 is going to be the year of the display. We saw more OLED gaming monitors than you can shake a redundant LCD backlight at, as well as some fantastic ultra-wide, large format, and high-refresh-rate screens. Narrowing it down to the 35 products here was a difficult task, but these are our picks for the best PC goodies of CES 2023.

© SAMSUNG, INTEL, AMD, NVIDIA

Odyssey Neo G9

SAMSUNG ODYSSEY NEO G9

If you're an ultra-wide aficionado, the Samsung Odyssey Neo G9 is a dream monitor. With its dual UHD 7,680x2,160 resolution, mini-LED tech, 240Hz refresh rate, HDR1000, and DisplayPort 2.1, it's the kind of screen that will last for years. Which is handy, because you'll probably need to wait that long for a GPU powerful enough to drive it.

There's no price or release date yet, but that gives you time to buy the huge desk you'll need to accommodate it.

- **Out: TBC**
- **www.samsung.com**
- **Price: $2,300+ (estimated)**

INTEL CORE I5 13400F

We loved the previous-gen Intel Core i5 12400 CPU from last year, and this is its successor. The big improvement is the addition of efficiency cores, meaning you now get six big Performance-cores and four smaller E-cores for your $210, which translates into a full 16 threads of processing power. That's more than enough for any modern PC game and a lot of grunt for productivity workloads, too. Add in BCLK overclocking, which is possible with some B660 and B670 motherboards, and it sounds like we have a winner.

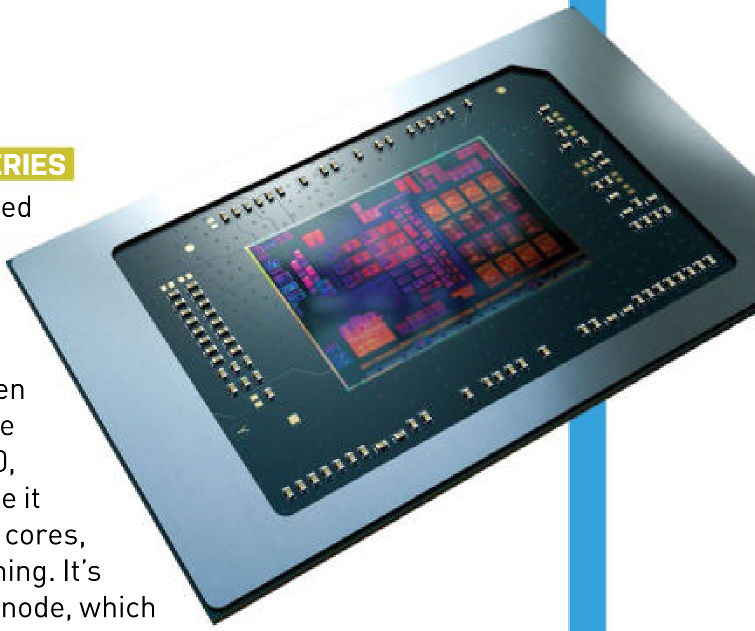
• Out now • www.intel.com • Price: $210

VIDEOCARDZ.COM

NVIDIA RTX 4090 MOBILE

There's a simple reason why this GPU has been included: at Nvidia's Vegas suite, we played *Assetto Corsa* on a triple-monitor racing rig, all from a 4090 laptop. Nvidia also announced 4070 and 4080 mobile processors, but it's the audacity of the 4090 that wowed us. No doubt it will be expensive when it makes its way into laptops, but for sheer power on the go, Nvidia has delivered here.

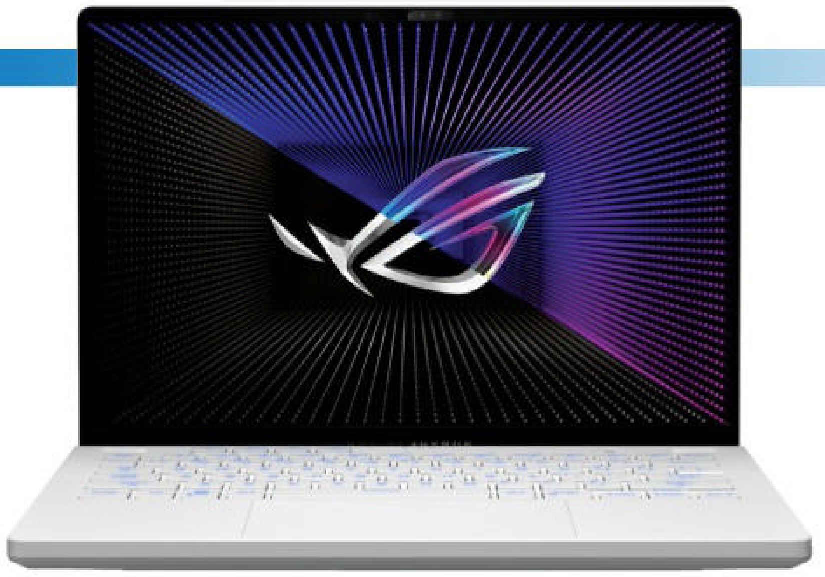
• Out: February 2023 • www.nvidia.com • Price: $3,000-4,000 (estimated)

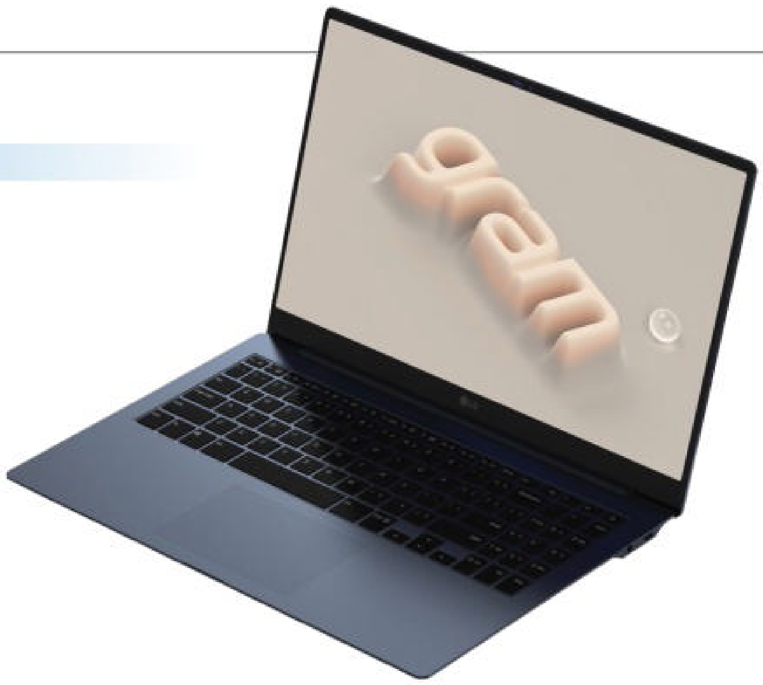


AMD RYZEN 7040 SERIES

AMD's Lisa Su presented the CES keynote this year and the company showed off some impressive new mobile CPUs. The Ryzen 7045 processor is more powerful than the 7040, but we chose it because it comes with up to eight cores, which is plenty for gaming. It's based on TSMC's 4nm node, which offers better efficiency than TSMC 5nm for up to 30-hour battery life, plus AMD's new AI engine tech. That should all add up to slick, slim, and surprisingly long-lasting gaming laptops. Hurrah!

• Out: March 2023 • www.amd.com • Price: TBC





ASUS ROG ZEPHYRUS G14

If you're not familiar with Asus's ROG Zephyrus line, it's pretty much out on its own as the most portable gaming laptop series out there, with only Razer really offering anything as slim and light. Amazingly, the new G14 is a 14-inch laptop that will come packing anything up to an Nvidia GeForce RTX 4090 and AMD Ryzen 9 7940HS. OK, the GPU will max out at 125W compared to something like the Razer Blade 16's 175W, but that's a necessity due to the machine's compact nature. It's the ultimate power and portability combo.
• Out: Q1 2023 • www.asus.com • Price: $3,000-4,000 (estimated)

LG GRAM ULTRASLIM

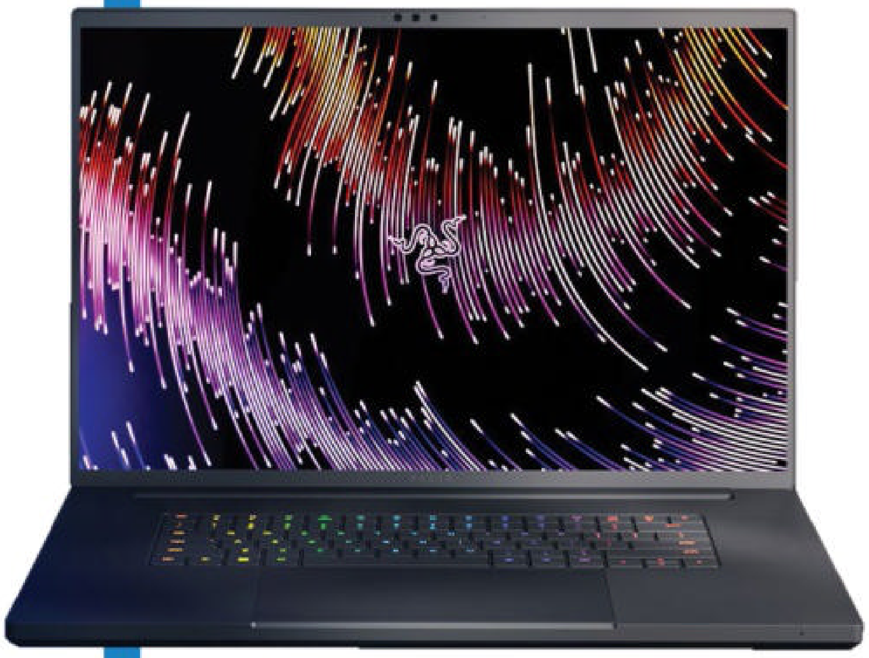
LG does two things well in the PC space —laptops and monitors. The LG Gram Ultraslim laptop is lighter and thinner than the previous model at just under a kilogram. This makes it appealing for road warriors, plus the 15.6-inch OLED display and 13th Gen Intel Core processor don't hurt either. It's a marvel to hold in real life and should be a top choice for anyone looking for a lightweight laptop.
• Out: Q1 2023
• www.lg.com • Price: TBC

RAZER BLADE 18

If you want a mobile desktop you can fold and take with you, the Razer Blade 18 is it. This year will see the rise of monster laptops, sporting 65W desktop-level processors and mighty RTX 4090 GPUs. The key feature is the QHD+ 16:10 2,560x1,600 240Hz screen, which fits in the body of a 17-inch. This is the gaming/productivity laptop to die for. Big is back, baby.
• Out: Q1 2023
• www.razer.com • Price: $3,500+ (estimated)

LENOVO YOGABOOK 9I

Featuring not one, but two 4K OLED displays, this is no ordinary laptop. That means that you can use both screens separately or combine the two to double the size. You can also place the physical keyboard on top of the second screen, leaving a thin OLED on the bottom. We love the look of the Yoga Book 9i—it's a niche product, but innovative and exciting, which is what CES should be about!
• Out: June 2023
• www.lenovo.com • Price: $2,100



N.O.E.
Night ghosts

© ASUS, LG, RAZER, LENOVO

RAZER EDGE 5G

This was announced just ahead of CES, but we got our paws on it at the show. It appears to be the ultimate game streaming device, thanks to the 5G connectivity that lets you play triple-A games, such as *Forza Horizon* and *Halo* through Xbox Game Pass. It's a lovely little tablet that can snap out of its game controller housing, and while we're still skeptical of streaming (especially on the go), this is a premium product.

• Out now • www.razer.com • Price: $600

Fortnite
CLOUD GAMING
DIABLO
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SAMSUNG MICROLED CX TV

OK, we know this is a TV, but as we said in the intro, CES 2023 was all about displays. Samsung is promising us microLED TV panels that are 500,000 times faster than its latest OLED displays, in the region of 2 nanoseconds. That's five million times quicker than a fast 1ms LCD gaming monitor. No doubt it will take many years before this technology makes it into monitors (let alone affordable ones), but here's to the future of latency-free displays. In the meantime, we'll just have to slum it on our OLEDs with their ridiculously slow 0.3ms response times.

• Out: TBC • www.samsung.com • Price: TBC

NVIDIA GEFORCE NOW ULTIMATE RTX 4080 MEMBERSHIP

Nvidia has figured out what to do with the RTX 4080 cards that people haven't been buying—stick 'em in the cloud. While that's harsh, it will at least give more gamers access to the raw performance power of Team Green's second-best GPU, plus DLSS 3 and Frame Generation in supported games. Plus, there will also be 240Hz, ultrawide monitor support, and latency of an impossibly low 23ms. The best bit is that the price isn't increasing from $20 a month—it should be available by the time you read this.

• Out now • www.nvidia.com • Price: $20 per month

ASUS ROG AZOTH

The Azoth is absolutely the finest keyboard Asus has ever created and the best tippy tapper to come out of this year's CES. The typing experience is superb, with Asus's custom ROG NX switches doing an impressive job for the company's first mechanical clickers, although they're also hot-swappable if you have other switch preferences.

There's also a small OLED panel in the top right, which tells you which profile you're on, how much battery is left, and whether you're connected via 2.4GHz wireless or Bluetooth.

• Out now • www.asus.com • Price: $300

© RAZER, SAMSUNG, NVIDIA, ASUS

ASUS ROG RAIKIRI PRO OLED CONTROLLER

Another officially licensed Xbox/PC controller is nothing new, but Asus's ROG Raikiri Pro goes all out with an OLED panel slapped on the top.

It's a 1.3-inch display that can play custom animations, show the status of the mic, or indicate the remaining battery life. The controller also comes with advanced features, such as physical switches to change the trigger actuation, a built-in ESS DAC and 3.5mm headphone jack, and joystick sensitivity and dead zone adjustment through the Armoury Crate app.

• Out: Q1 • www.asus.com • Price: $180

ACER CHROMEBOX CXI5 ADD-IN-ONE 24 MONITOR

Acer's micro-PC is pretty standard when it comes to Chromeboxes, although it is relatively powerful with its 12th-generation Intel Core i7 processor, Iris Xe graphics, 16GB of DDR4 RAM, and 256GB SSD. But the interesting part is that it's designed to slot straight into Acer's 'Add-In-One' 24-inch Full HD Monitor, meaning you can create a neat all-in-one PC. With the monitor sporting a 5MP webcam, 4W speakers, and dual microphones, this is the ideal setup for video conferencing, especially if you have limited space.

- Out: Q1 2023 • www.acer.com
- Price: From $610 (bundle)

HTC VIVE XR ELITE

HTC has returned with its first standalone XR headset that offers a little something for everyone. For anyone interested in a great VR experience, the Vive XR Elite will offer a 3,840x1,920 combined resolution, up to 110° field of view, and a 90Hz refresh rate.

There are four onboard tracking cameras for controller tracking and a depth sensor. However, it also has an ultra-vivid passthrough mode that allows you to interact with AR objects as well.

• Out: February 2023 • www.vive.com • Price: $1,099

© ASUS, ACER, HTC

MSI SPATIUM M570 PRO

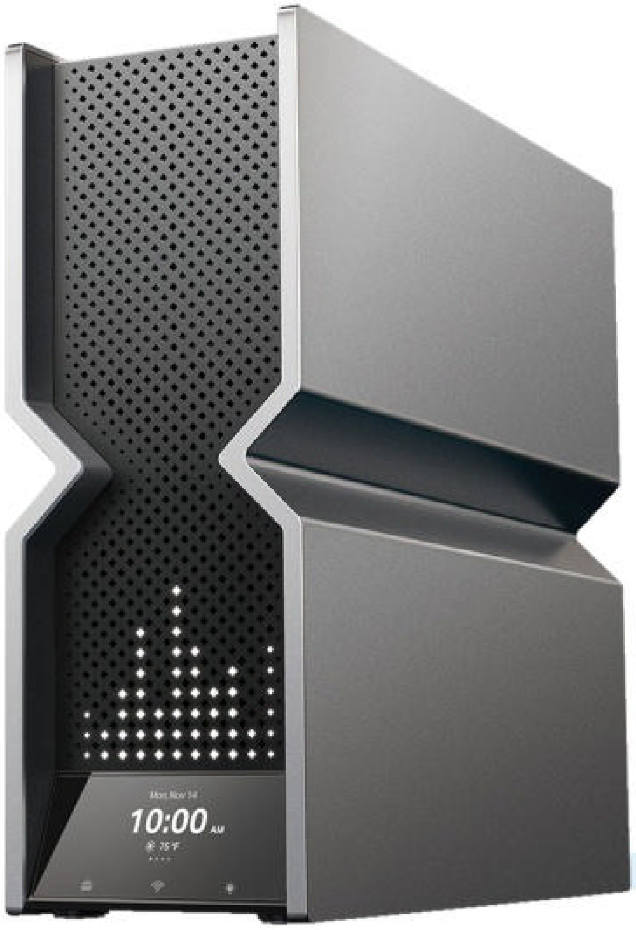
PCIe 5.0 SSDs have finally arrived! The MSI Spatium M570 Pro promises sequential read and write speeds of 12,000 and 10,000MBps. And on a test desktop at MSI's suite, we saw it had returned rates of more than 12,000 and 11,000MBps on CrystalDiskMark. It stays cool using a vapor chamber plate, paired with a finned aluminum heatsink. It will be available for purchase in 1TB, 2TB, and 4TB capacities and will appear in MSI laptops from Q2.

• Out: Q2 2023 • www.msi.com • Price: from $200

TP-LINK ARCHER BE900

The Archer BE900 is our standout Wi-Fi 7 router thanks to its unique V-fold design with two screens. While the touchscreen at the bottom has a clock and other useful system information is just a swipe away, the LED screen above it displays the weather, text, emojis, and 3,000+ customized graphics. On the rear, there are two USB ports, a gigabit LAN port, four 2.5Gbps LAN ports, a 10Gbps WAN/LAN port, and even a 10Gbps Fiber/Ethernet combo WAN/LAN port.

• Out: Q1 2023 • www.tplink.com • Price: $700



F1:1.7
8.5MM
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WIDE ANGLE AF-LENS
RAZER
4K ULTRA HD

RAZER KIYO PRO ULTRA

We were astonished at the video quality from Razer's new high-end webcam, which promises the clarity of a DSLR camera, only without the complications and potential battery overheating problems. The Kiyo Pro Ultra has a Sony 1/1.2-inch Starvis 2 sensor that Razer claims is the largest image sensor ever in a webcam, along with an F/1.7 aperture lens to let in low light. It can record at up to 4K 30fps or 1080p 60fps and even has an HDR mode.

• Out now • www.razer.com • Price: $299

THERMALTAKE SWAFAN EX12/EX14

These 120mm or 140mm RGB fans come in packs of three and attach to each other magnetically via pins, so you only need to run a data or power cable to the first one. There are also two different blades per fan, one for blowing air into the case and another for expelling it. We were impressed with how easy it was to snap the blades in and out. They come with 20 addressable RGB lights each.

• Out now • www.thermaltake.com
• Price: from $95

thermaltake

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SONY PROJECT LEONARDO

While Sony appears to be following Microsoft's lead, first with a premium gamepad and now an accessibility-friendly controller, Project Leonardo does look completely different from the Xbox Adaptive controller.

Project Leonardo works on its own, with another unit, or even with a DualSense controller, and comes with extra auxiliary ports so you can attach further accessories, such as Logitech's Adaptive Gaming Kit. This means that PC and PlayStation games will be accessible to more people than ever, and that's no bad thing.

• Out: TBC • www.playstation.com • Price: $100 (estimated)

ASUS ROG SWIFT OLED PG27AQDM

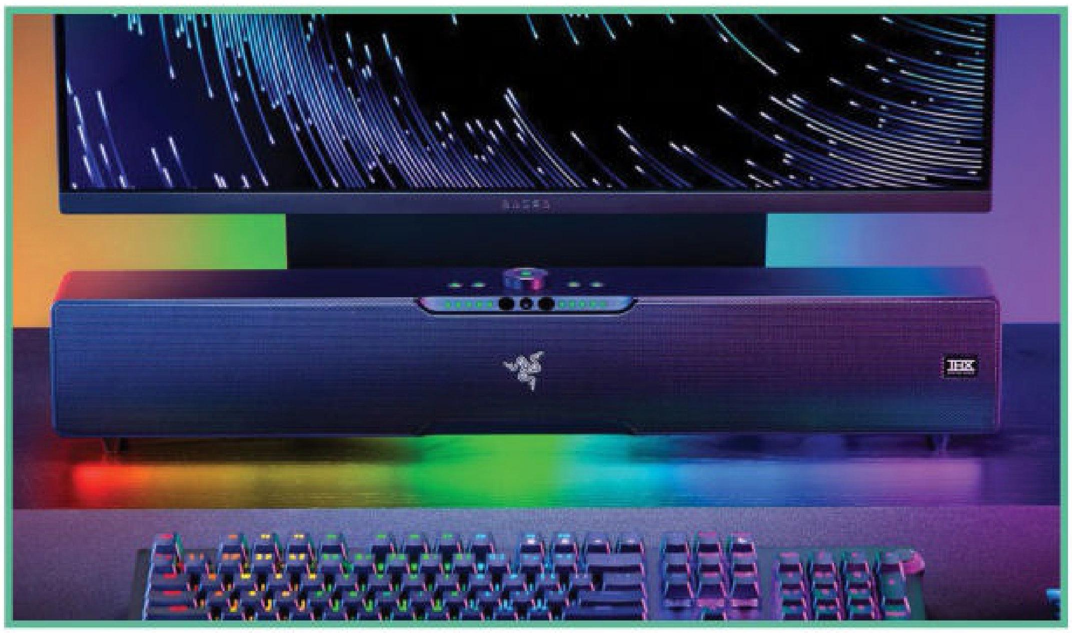
Asus brings OLED panel tech to its 27-inch monitor. The ROG Swift OLED PG27AQDM has a WQHD (2560x1440) display with a 240Hz refresh rate and a 0.03ms response time, with 1,000 nits of peak HDR brightness. A custom heatsink and cooling vent also reduces temperatures by up to 5°C. • Out: Q1 2023 • www.asus.com • Price: TBC

DELL CONCEPT LUNA

Dell's Concept Luna was first shown off in late 2021, but at CES, the upgrade-and-repair project had advanced considerably. We were shown how, with just a SIM card tool pin, you could disassemble the XPS 13-like laptop down to its core components in a matter of seconds.

Everything locks together like Lego blocks, in a way that makes rival Framework Laptop's assembly look complicated by comparison. There's no confirmed release date, but it's good to see Dell can make a laptop that's easy to access, even if it isn't available yet.

• Out: TBC • www.dell.com • Price: TBC



RAZER LEVIATHAN V2 PRO

Soundbars can be quite boring, producing decent stereo sound with a wide soundstage without ever striving to do much else. The Razer Leviathan V2 Pro attempts something new—head-tracking spatial audio with the help of infrared cameras.

The result not only sounds like you're listening to everything in Dolby Atmos, but all the processing is done right on the soundbar. That means you can connect it to any laptop or desktop to get premium sound without installing any extra software.

• Out now • www.razer.com
• Price: $400

© SONY, DELL, ASUS, RAZER.

ACER EKINEKT BIKE DESK 3

This bike desk allows you to work, get fit, and power your laptop at the same time. The kinetic energy generated—up to 75W of power from a relaxed pace— will charge your devices. The desk has two USB Type-A ports and one USB Type-C port, plus a smartphone app that monitors your workout. The desk allows you to sit upright and type, or sit forward for a vigorous standing workout.

• Out: June 2023 • www.acer.com • Price: $999

HYTE Y40

Our favorite case of CES 2023 goes to one that looks great but doesn't cost a fortune. It's already on sale for $149, with the standout feature being the panoramic view of your components thanks to the two glass panels.

The $149 price tag is even more impressive, given that a fancy PCIe 4.0 GPU riser cable is included. On thermals, there's an intake in the bottom, where one of the 120mm fans is housed, and the right front where you can fit up to two 140mm spinners.

• Out now • www.hyte.com
• Price: $149

VIEWSONIC VX16-OLED

The portable monitor category is expanding, and this one grabbed our attention due to it cramming a 4K resolution into a 15.6-inch form. As its name implies, it also uses an OLED panel for those gorgeous inky blacks. The VX16-OLED is rated to cover 100 percent of the sRGB and DCI-P3 color gamuts while maxing out at 400 nits at 60Hz—not ideal for gamers, but photographers and video editors working on the go will love it.

• Out: H2 2023 • www.viewsonic.com • Price: $400

ALIENWARE AW2524H

Gaming laptops with 240Hz displays are becoming standard, but that's nothing compared to this Alienware 500Hz Gaming Monitor. Few games can take advantage of such a high refresh rate yet, but you'll still get a buttery smooth experience—especially when playing competitive titles.

The monitor also has a super low 0.5ms response time that will help you get the edge in online matches. This may not be the flashiest-looking monitor of CES 2023, but its insanely high refresh rate can't be topped.

• Out: February 2023 • www.alienware.com • Price: $1,000 (estimated)

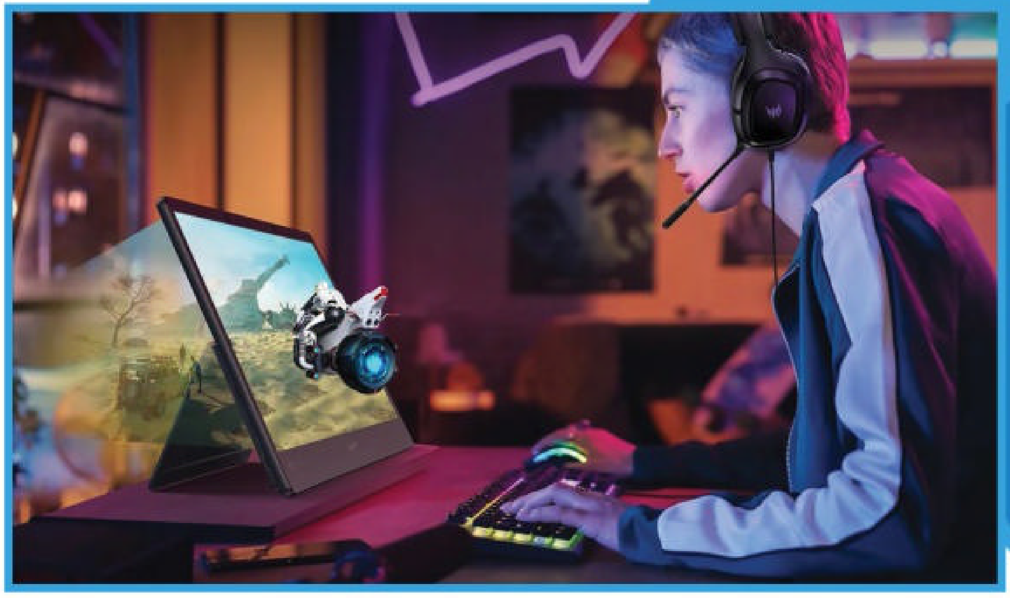
© HYTE, ACER, VIEWSONIC, ALIENWARE

LENOVO THINKPHONE BY MOTOROLA

Since the death of the BlackBerry, the 'business' phone has become something of a relic, but this has some of the DNA of the ThinkPad laptops in phone form. There's a Moto KeySafe security chip and AI Threat Defense software to make sure company secrets stay safe, great cross-platform features with ThinkPads, and the Red Key, which can bring up shortcuts or apps of your choice. It looks decent specs-wise, with a 144Hz OLED screen, multi-lens camera system, and 1.25m drop resistance.
• Out: January 2023 • www.lenovo.com • Price: $1,000 (estimated)

ACER SPATIALLABS TRUEGAME 3D ULTRA MODE

The '3D Ultra Mode' part is why we've included this tech on our list. Acer's SpatialLabs TrueGame tech already provides glasses-free 3D gaming on laptops and displays, but the 3D Ultra Mode is more convincing than ever. Using cameras to track your eyes, it creates a targeted 3D effect, so you get the best possible depth effect. Everyone else sees a double image but, for you, it's a world with convincing depth.
• Out now • www.acer.com
• Price: Free



SYNOLOGY DS723+

The DS723+ is the latest network-attached storage device from Synology for those who don't need lots of disk drives but want the features of the company's '+' models. It can store up to two 3.5 or 2.5-inch drives in the main body, plus up to two M.2 SSD drives in the bottom for applications that require regular, fast access to data. There's also a 2.5Gb Ethernet port for faster networking.
• Out now • www.synology.com
• Price: $450

MSI MODERN 14

The MSI Modern 14 is the answer to the question "I want a PC that looks like a Macbook, what should I get?". The Beige Mousse hue is similar to Apple's Rose Gold colorway, but there's more than just beauty here—it also boasts a modern 13th Gen Intel Core i7 processor alongside the latest Intel Iris Xe graphics. It's also MIL-STD-810G certified, meaning it's been tested against vibration, shock, low pressure, high pressure, and both high- and low-temperature damage.
• Out: TBC • www.msi.com • Price: TBC

© LENOVO, DISPLACE, SYNOLOGY, MSI

TCL NXTPAPER 12 PRO

This is a 12-inch Android tablet with one trick unique to TCL—the Nxtpaper screen. This display uses a traditional LCD panel built with coverings that cut out a huge amount of the blue light, cut back on reflections, and has a subtle texture that feels a little like paper, which is pleasant to draw on with the stylus. The 2,160x1,440 resolution screen isn't as sharp as other Android rivals, but this is a unique tablet that will win over those who love to write and draw.

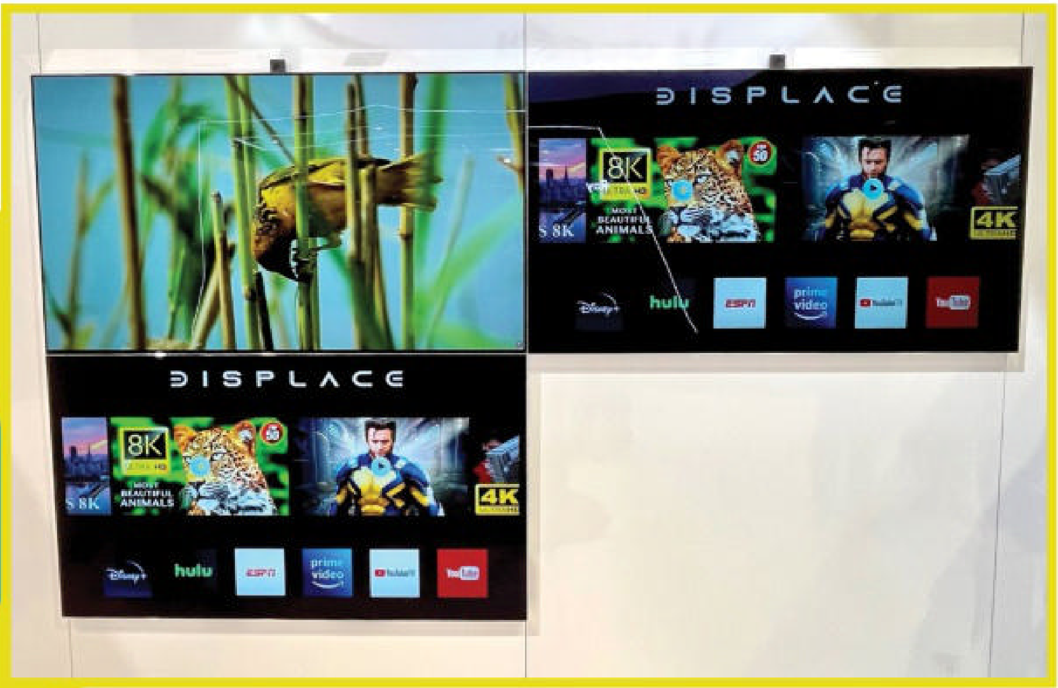
• Out now • www.tcl.com
• Price: $499

HYPERX 3D PERSONALIZATION

Now under the ownership of HP, HyperX showed how it was leveraging the company's 'best-in-class 3D printing technology' to allow for all sorts of customizations for its keycaps, mouse add-ons, headset backplates, and headband attachments.

HyperX is planning several limited-edition keycaps to kick things off, the first of which is the Cozy Cat mascot (pictured). It will fit all of HyperX's boards with swappable keycaps, as well as any standard Cherry MX-style keys. Costing $20, it should be available now.

- Out now • www.hyperx.com
- Price: $20



DISPLACE TV

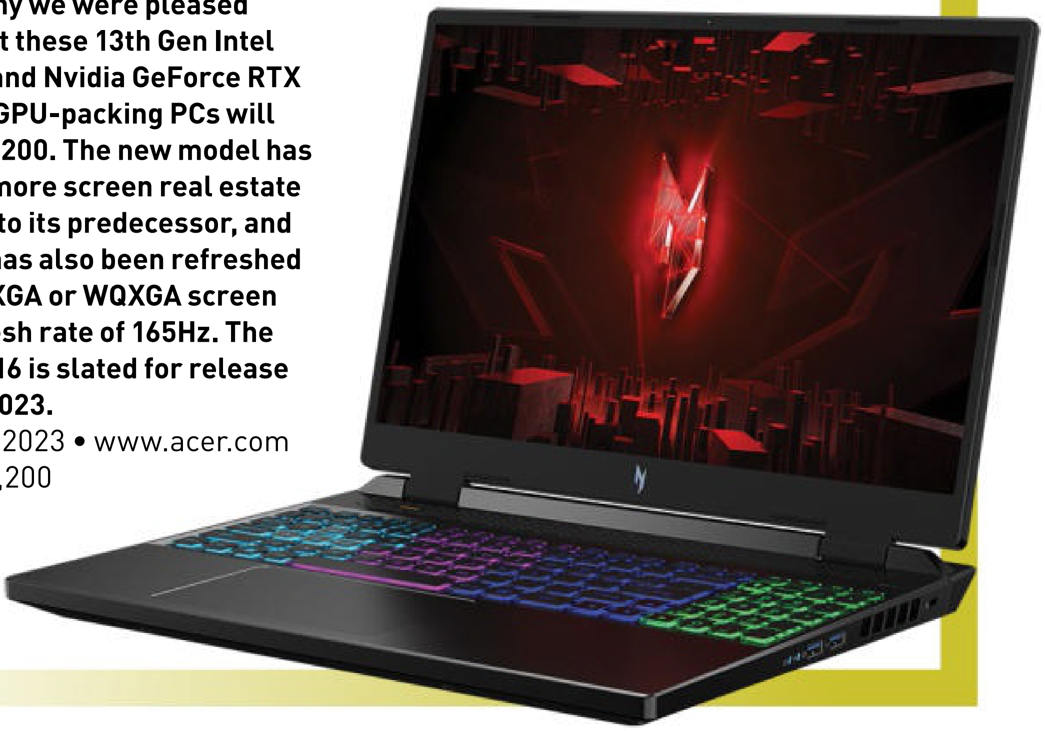
This TV has no wires—it runs on four hot-swappable batteries—while an active-loop vacuum system means you can stick it to the wall without a mount, and combine multiple units together to make even bigger displays. It receives content via a separate box that can be tucked away in a cupboard and communicates wirelessly with the TV. In theory, you could join 16 of them together to make a 220-inch TV, if you have a big enough wall.

• Out: Late 2023 • www.displace.tv • Price: $3,000

ACER NITRO 16

Acer's Nitro range caters to the more value-conscious gamer, which is why we were pleased to hear that these 13th Gen Intel Core CPU and Nvidia GeForce RTX 40-series GPU-packing PCs will start at $1,200. The new model has 5 percent more screen real estate compared to its predecessor, and the panel has also been refreshed with a WUXGA or WQXGA screen and a refresh rate of 165Hz. The new Nitro 16 is slated for release in Spring 2023.

- Out: May 2023 • www.acer.com
- Price: $1,200



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BEST FREE DOWNLOADS FOR 2023

Make the most of your PC this year without spending a dime. ***Robert Irvine*** reveals all the best free software, apps, and downloads to get you through the year ahead

WHAT YOU CAN DO

- Remove hidden PC junk using Microsoft's new clean-up tool
- Back up files and drives without paying for premium options
- Try Thunderbird's new Android app
- Legally download thousands of classic books for free
- Download high-quality films to watch over the next year
- Save old radio shows to your PC or phone to play offline
- Download free music from YouTube

AFTER A STRESSFUL 2022, during which almost everything became more expensive, most of us will be watching our finances carefully this year. When the cost of basic items, such as fuel, food, and household bills, keeps going up, spending even a few dollars on a program, mobile app, or book can seem an extravagant and unnecessary luxury, even though in the past you may have splashed out without a second thought.

There's always been plenty of free software around, but with developers increasingly limiting useful options to paid-for versions or scrapping their free programs altogether even this is becoming more scarce.

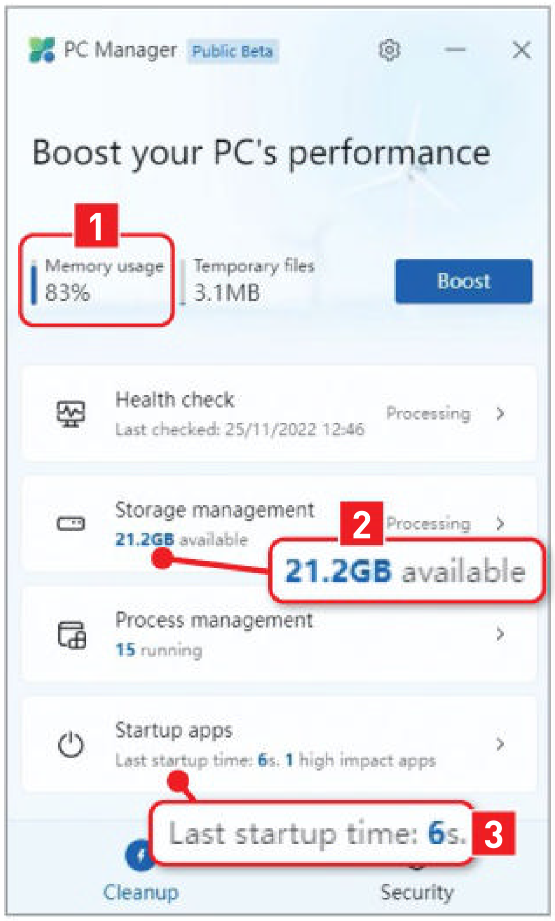
However, it's not all doom and gloom, and there is still lots of great stuff you can get for free, provided you know where to look. Here, we recommend the best software and apps you should download, both to replace popular tools that will disappear soon and to try exciting new features before everyone else. We also reveal where to find other fantastic freebies, including ebooks, audiobooks, films, games, and much more.

All of our recommendations will have special relevance and usefulness in 2023, and will hopefully make the next year cheaper and easier than the last.

FIVE NEW FREE PROGRAMS YOU MUST DOWNLOAD

1. Microsoft PC Manager

Microsoft caused a stir in October 2022, when it quietly released a new PC clean-up tool called PC Manager through a Chinese website. The free app has since been added to the Microsoft Store (though its page is currently hidden) and now has an English-language website (pcmanager-en.microsoft.com), and we expect it to be officially launched in the first half of the year. Although PC Manager is still at the 'public beta' stage, it already provides a fast and effective way to clean and speed up your computer. You can remove junk files and space hogs, disable unwanted startup items and background processes, and scan your PC for threats and driver updates.


PC Manager Public Beta

Boost your PC's performance

Memory usage 83%

Temporary files 3.1MB

Health check
Last checked: 25/11/2022 12:46
Processing

Storage management
21.2GB available
Processing

Process management
15 running

Startup apps
Last startup time: 6s. 1 high impact apps

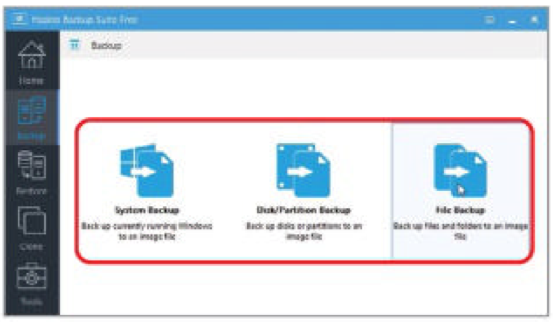
Microsoft PC Manager is a new free way to clean and speed up your PC.

The app is easy to use and integrates seamlessly with Windows 10 and 11 to perform clean-up tasks with a single click and reveal useful information about your system. This includes your current memory usage (1 in our screenshot below left), how much storage you have available 2 and how long your PC takes to start 3. PC Cleaner is worth downloading now to try a simpler, if less sophisticated, alternative to CCleaner and BleachBit. You may experience a few bugs, but Microsoft is regularly updating the app to fix reported problems.

When we tested PC Manager, we noted that 'treats' were found and there was a nagging suggestion to change our browser to Edge. In the latest beta version, this has been corrected to 'threats' and PC Cleaner now respects and protects your default browser. We can't wait to see its first stable release. Be aware that some Windows users have experienced problems when trying to install PC Manager—see our box below for potential fixes.

2. Hasleo Backup Suite 3

In sad news for users of Macrium Reflect Free—and we know that includes many *Maximum PC* readers—the excellent free backup program is being retired. Although you'll still be able to use the current version of the software (Reflect 8 Free), it will no longer be updated and won't receive security fixes after 1 January 2024. This puts your backups at risk from vulnerabilities that could allow hackers to steal your files.


Hasleo Backup Suite Free
Backup
Home
Backup
Restore
Clone
Tools
System Backup
Back up currently running Windows to an image file
Disk/Partition Backup
Back up disks or partitions to an image file
File Backup
Back up files and folders to an image file

Hasleo Backup Suite lets you back up your system, hard drives, and specific files.

It also means it's wise, if not essential, to find an alternative backup solution this year. You may be familiar with Paragon's 'Backup & Recovery' Free Edition (www.paragon-software.com/free/br-free/) and AOMEI Backupper Standard (www.aomeitech.com), which are free versions of paid-for backup software with some features missing, but a new option to consider in the new year is Hasleo Backup Suite (www.easyuefi.com/backup-software/backup-suite-free.html).

Free to use, with no options locked behind Upgrade buttons, version 3 (released in November 2022) provides everything you need to back up your hard drives, partitions, and the entire system, and now also lets you back up specific files and folders.

Hasleo Backup Suite 3 is easy to use—simply click New Backup on its home screen, choose System, Disk/Partition, or File Backup (see screenshot above), then select the relevant item(s) and backup destination, and click Proceed. You can secure your backups by encrypting them, compress your files to save space, and choose between full, incremental, and differential backups.

The software also lets you schedule your backups to run at the frequency and time of your choice, as well as offering a Clone tool for copying your current Windows installation to another PC.

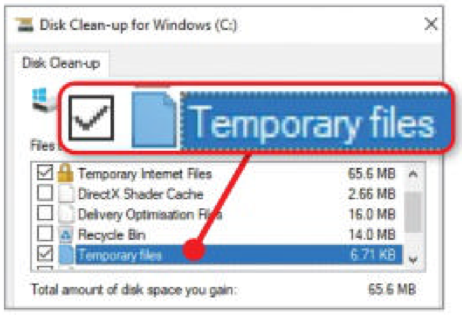
3. Paint.NET 5

Packed with powerful tools and useful effects, Paint.NET has long been one of our favorite free image editors. But although it's been updated many times over the years, the last major version (Paint.NET 4.0) was released in 2014 and since then, rival programs such as GIMP and PhotoDemon have lured users away.

What to do if PC Manager won't install

If you experience problems installing Microsoft PC Manager, try running the tool as an administrator. Right-click the downloaded 'MSPCManager Setup.exe' file, choose 'Run as administrator', and click Yes to allow the app to make changes to your device.

If that doesn't help, try deleting temporary files using Disk Clean-up, which is ironically the tool that PC Manager is designed to replace.


Disk Clean-up for Windows (C:)

Disk Clean-up

☑ Temporary Internet Files 65.6 MB
☐ DirectX Shader Cache 2.66 MB
☐ Delivery Optimisation Files 16.0 MB
☐ Recycle Bin 14.0 MB
☑ Temporary files 6.71 KB

Total amount of disk space you gain: 65.6 MB

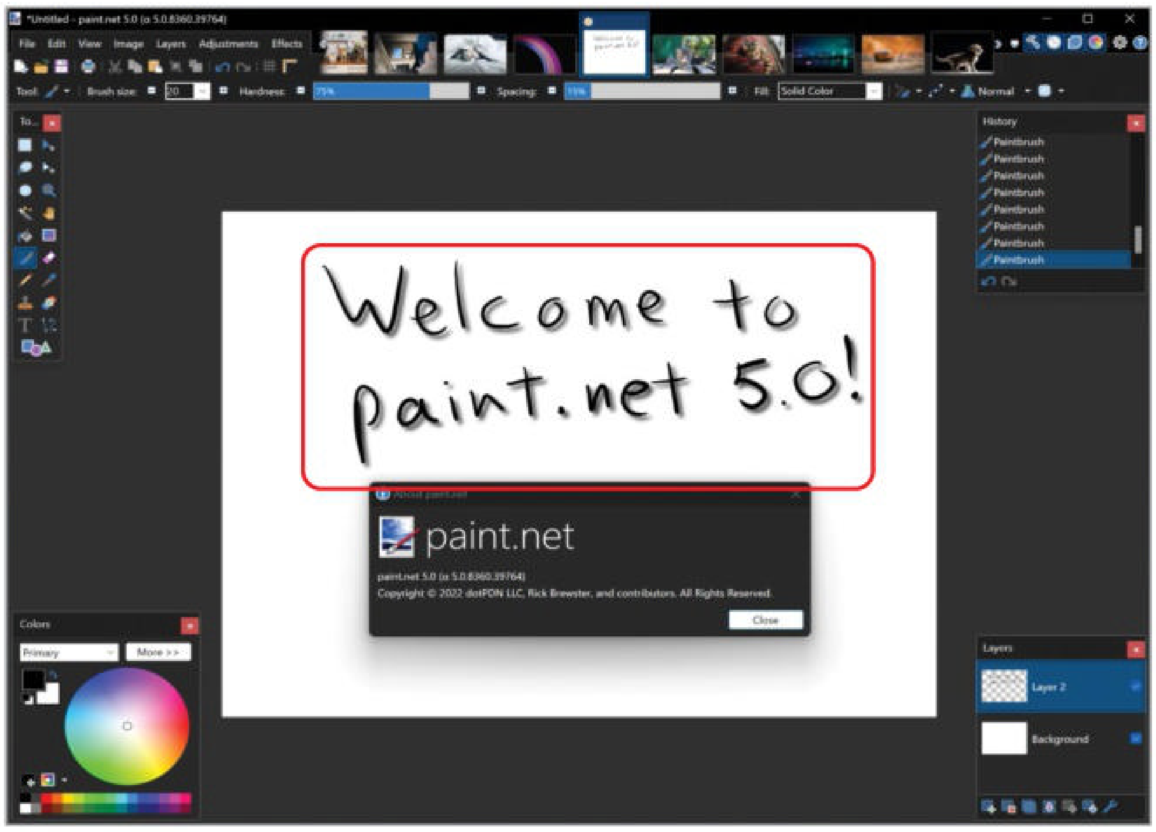
Type disk into the Windows search box, click 'Disk Clean-up', select your hard drive and click OK. Tick the boxes for Downloaded Program Files, Temporary Internet Files, and 'Temporary files' (see screenshot), then click OK to delete them. Your antivirus software may be blocking PC Manager because the tool is still in beta and not recognized. Try disabling its protection temporarily, then restart your PC and run PC Manager again.

So we're excited that this year will see the arrival of Paint.NET 5, which is optimized for modern computers and current ways of working with graphics. In fact, if you don't mind a few bugs, you can download an 'alpha' preview version right now (tinyurl.com/48nh7fxz—click the 'paint.net.5.0.8361.33457.install.x64.zip' link).

Paint.NET 5 switches to using your PC's graphic processor to render images and perform most of its tasks. This makes it faster and more stable, improves picture quality and color accuracy, and also boosts battery life if you're using it on your laptop.

There are plenty of new adjustments you can apply to your images, including Exposure, 'Highlights & Shadows' and 'Temperature & Tint', and effects such as Straighten and Drop Shadow. We're particularly looking forward to trying the new Bokeh effect, which lets you blur the background of photos while keeping the subject in focus. Previously, these options required you to install plug-ins.

Existing effects have been enhanced and Paint.NET has added 'pressure sensitivity' to let you write and draw with natural-looking brush strokes (see screenshot above right) using a stylus pen or graphics tablet. Expect even more features in the final release.



Paint.NET 5 adds plenty of new tools, including pressure sensitivity for stylus pens.

4. ChromeOS Flex

After 10 January 2023, Microsoft will no longer provide security updates or technical support for Windows 7 or 8.1 (support for Windows 7 ended in January 2020, but extended security updates were still available).

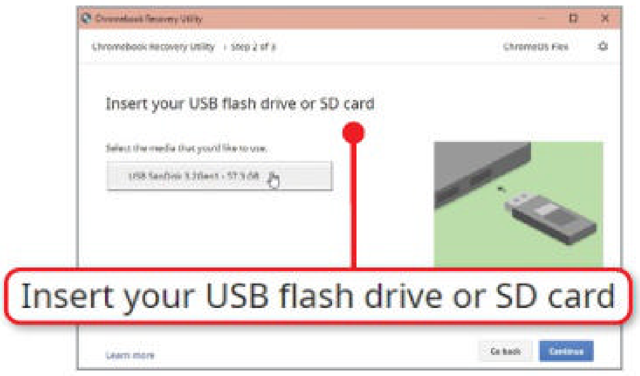
This means that if you have an old laptop running either of those operating systems, it's no longer safe to use it to go online because it will be vulnerable to malware. Microsoft has stopped offering free upgrades from Windows 7 or 8.1 to Windows 10 or 11, but you can give your laptop a new lease of life by downloading ChromeOS Flex.

This new operating system from Google effectively turns a Windows PC or Mac into a Chromebook and works on most computers with at least 4GB of RAM, 16GB of storage, and a 64-bit processor. It gives you instant access to Google tools including Gmail, Drive, and YouTube, it's simpler than Linux, more secure than Windows, and it's free.

To set up ChromeOS Flex, you first need to install a Chromium extension called Chromebook Recovery Utility (tinyurl.com/4xmjyfcc). This lets you create a bootable version of the operating system on an 8GB USB stick (see screenshot below left). If you need help, you can follow Google's instructions (https://tinyurl.com/mrfeyf39).

Once you've successfully booted ChromeOS Flex, you can permanently install it on your old laptop, which will wipe Windows and all your data, or continue running it from your USB stick. Choose the latter option first to ensure ChromeOS Flex connects to your home network and works properly then, if you're happy with it, keep using it.

Check how long your device will be supported at tinyurl.com/2p997jf3.


Chromebook Recovery Utility
Insert your USB flash drive or SD card
Insert your USB flash drive or SD card
Go back
Continue
Learn more

Install ChromeOS Flex on a USB stick to turn an old laptop into a Chromebook.

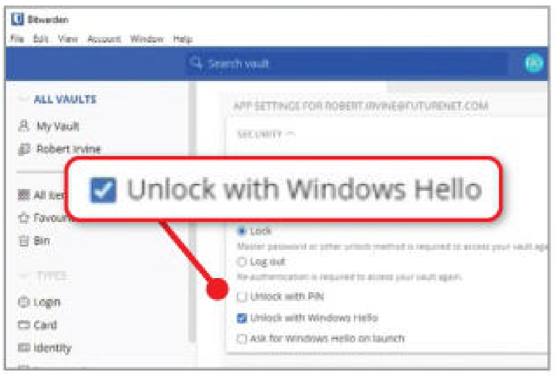
5. Bitwarden Free

Five years after it launched, the free password manager RememBear, from the company behind the TunnelBear VPN, will be discontinued on 18 July 2023.

"By the time RememBear was released, many users had already found their password solution and switching to a new service was too much to ask," the team said in a blog (www.remembear.com/blog). But if you're looking for a more secure and versatile way to manage your passwords than the password manager built into your browser, and don't like the restrictions imposed by LastPass on free accounts, Bitwarden Free (www.bitwarden.com) is your best option.

Bitwarden had a good 2022, introducing useful features, such as the ability to generate unique usernames and create email aliases using services including Firefox Relay and DuckDuckGo Email Protection. It also added support for passwordless logins through Touch ID, Windows Hello (see screenshot, below left), and other biometric methods. These make securing your accounts much easier and are set to become more widely used in 2023, while Bitwarden is certain to continue its innovative streak.

Bitwarden's basic free plan gives you all the features you need to store and secure your passwords, payment card details, and identity information. You can sync your data across an unlimited number of devices using its desktop and mobile apps, browser extensions, and web vault and import details from other password managers, including your browser's.

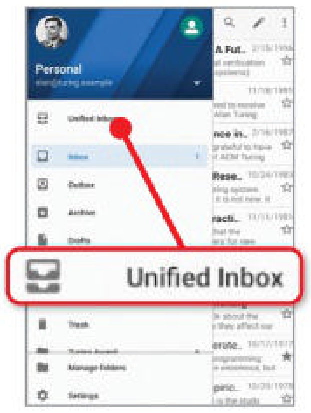


Bitwarden now supports password-free logins, which are set to be popular in 2023.

FIVE FREE APPS YOU MUST DOWNLOAD

6. Thunderbird for Android

Whatever email service you use, we recommended Mozilla's Thunderbird as one of the best ways to access your emails from those services on your desktop. The only problem is that Thunderbird doesn't have a mobile app, so you can't send and receive messages while you are using your phone or tablet. Happily, Thunderbird has now confirmed that an Android app is in development (there's no word on an iOS version) and is likely to be released in mid-2023.


Personal
Unified Inbox
Inbox
Outbox
Archive
Drafts
Trash
Manage folders
Settings
Unified Inbox

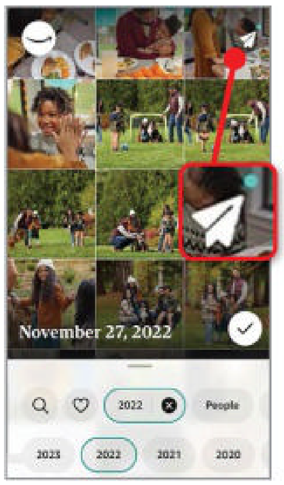
Thunderbird for Android will be based on K-9 Mail, which you can download

If you can't wait that long, you can preview it now by downloading K-9 Mail (tinyurl.com/2p98pp72), which will eventually evolve into Thunderbird for Android. The free app has a unified inbox (see screenshot above) for emails from all your accounts, supports OpenPGP end-to-end encryption, and lets you read messages without being tracked.

7. Amazon Photos

On 31 October 2022, Amazon removed its Drive app from the Google Play and Apple app stores, and on 31 December 2023 the online storage service will be permanently shut down. But if you only store photos and videos in Drive, you can use Amazon Photos instead—in fact, your files are probably synced with it already.

The free Amazon Photos app for Android (tinyurl.com/58vwhkya) and iOS (tinyurl.com/zcd6acuz) was recently redesigned to improve its search filters and let you share pictures and videos privately (see screenshot below left). It backs up your photos automatically so you never lose them, and also lets you use them as a screensaver on your Amazon Fire TV stick.


November 27, 2022
2022
People
2023
2022
2021
2020

Amazon Photos backs up your pictures and lets you share them privately.

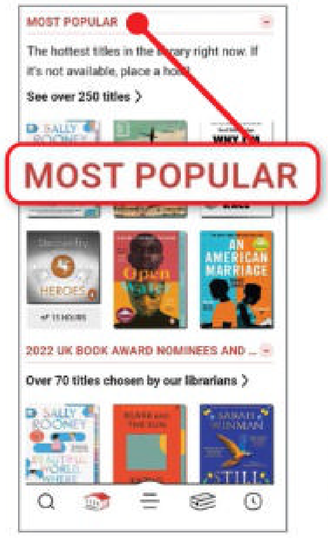
Amazon Prime members get unlimited photo storage and 5GB for videos, while non-Prime users get 5GB for both. There are also desktop apps for Windows and macOS.

8. Libby, by OverDrive

This year will close the book on the OverDrive app, which lets you borrow ebooks and audiobooks from your local library to enjoy on your phone or tablet.

It will soon be removed from the app stores and has been replaced by 'Libby, by OverDrive' for Android (tinyurl.com/nj8vd9hj) and iOS (tinyurl.com/2s3jacef).

Libby offers the same choice of titles in more than 40,000 libraries around the world, but has a more modern look, with lists of popular books (see screenshot above) and recommendations from librarians. Simply search for a library by name or location, then either sign in with your library card or request one. You can browse available ebooks, audiobooks, and magazines and download them to the app for free. Libby alerts you when your loan period is about to expire so you can return titles and borrow more.


MOST POPULAR
The hottest titles in the library right now. If it's not available, place a hold.
See over 250 titles
MOST POPULAR
2022 UK BOOK AWARD NOMINEES AND ...
Over 70 titles chosen by our librarians

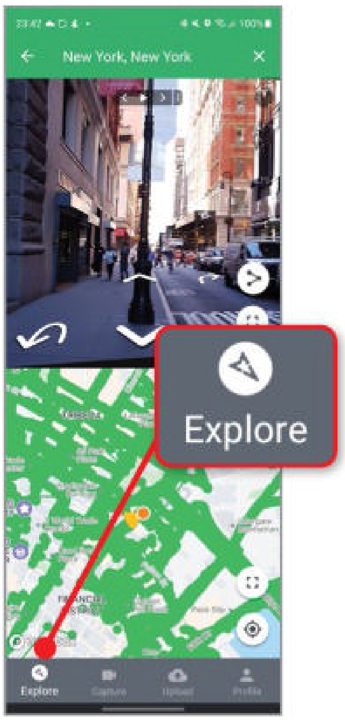
Libby makes it easy to borrow ebooks and audiobooks from your local library.

9. Mapillary

Google made the surprising decision to scrap its popular Street View app in March 2023. You'll still be able to access Street View in Google Maps, but as that app is crowded with other features, many of us will miss the simple standalone version.

One alternative is to download Mapillary for Android (tinyurl.com/2p9d3vv4) and iOS (tinyurl.com/3ktcb7na), which lets you both explore and capture street-level imagery. Sign up for a free account or use the app as a guest, then either search for a location or let Mapillary detect where you are. Press 'Explore' (see screenshot right) and tap the green lines and dots on the map to view photos taken by other users. Click 'Capture' to record and upload your own images.

Mapillary isn't as comprehensive as Street View, and its coverage of some areas of the US is rather sparse. But its imagery is constantly improving and it was recently updated to fix performance-related issues. Hopefully, this will increase its poor rating on the Google Play Store.

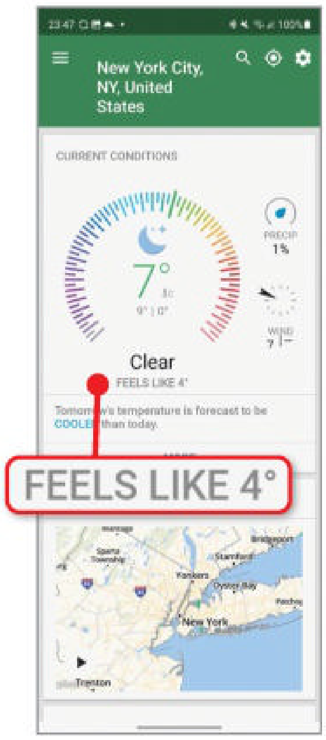

New York, New York
Explore
Explore
Capture
Upload
Profile

Explore street-level imagery in Mapillary when Google scraps its Street View app.

10. Weather Underground

Two-and-a-half years after it removed its Dark Sky weather app from the Google Play Store, Apple has now discontinued the iOS version too. Dark Sky's technology has been integrated with the Apple Weather app, but there are lots of other options for getting forecasts in 2023.

Weather Underground is our favorite because it combines a Dark Sky-level of detail with a simple, attractive interface and it's free to download and use (you can pay a small fee to remove ads). Get accurate hourly and daily forecasts for the next 10 days, including the chance of rain, wind speed, and 'feels like' temperatures (see screenshot), set up weather alerts, view radar and satellite maps, and more. The app works on Android (tinyurl.com/46mbmkbp) and iOS (tinyurl.com/4rfr9m6e).


New York City, NY, United States
CURRENT CONDITIONS
7°
PRECIP 1%
WIND
Clear
FEELS LIKE 4°
Tomorrow's temperature is forecast to be COOLER than today.
FEELS LIKE 4°
Stamford
Yonkers
Oyster Bay
New York
Trenton

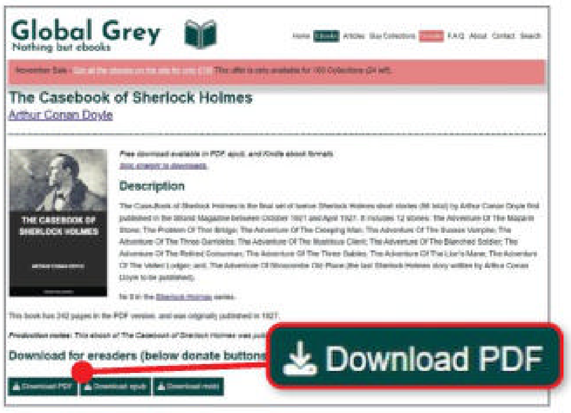
Weather Underground gives you hourly and daily forecasts for the next 10 days.

DOWNLOAD FREE ENTERTAINMENT

11. Classic books that are now out of copyright

In most countries, copyright law works on the principle of 'life plus 70 years', which means that books enter the public domain 70 years after the death of the author. However, in the US, works created before 1 January 1978 are protected for 95 years from the date they were copyrighted. This means that many classic books published in 1927 will enter the public domain in 2023 and you'll be able to download them as free ebooks from websites such as Project Gutenberg (www.gutenberg.org).

Notable titles include *To The Lighthouse* by Virginia Woolf, T*he Case Book of Sherlock Holmes* by Sir Arthur Conan Doyle, and HP Lovecraft's *The Color Out of Space*, but due to the difference in copyright law, all three are already available from the excellent UK site Global Grey (www.globalgreyebooks.com). This offers more than 2,400 public-domain ebooks from hundreds of famous authors to download legally for free. You can choose between PDF, EPUB, and MOBI formats, depending on which device you plan to read on (none of the books are DRM-protected), and don't need to register any details—click the relevant Download button (see screenshot below).


Global Grey
Nothing but ebooks
The Casebook of Sherlock Holmes
Arthur Conan Doyle
Description
Download for ereaders (below donate buttons)
Download PDF

Global Grey offers thousands of classic books to download legally for free.

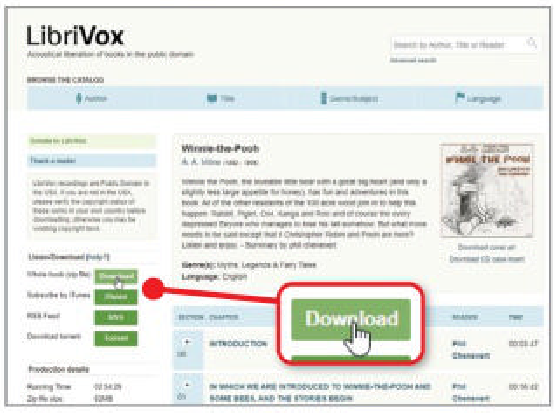
12. Audiobooks you don't have to pay for

If you prefer listening to books to reading them, the audiobook service LibriVox (librivox.org) will also be adding lots of newly out-of-copyright titles in 2023. It already offers more than 45,000 audiobooks, which are read by volunteers from all over the world and can be downloaded as ZIP files containing MP3s of each chapter (see screenshot above).

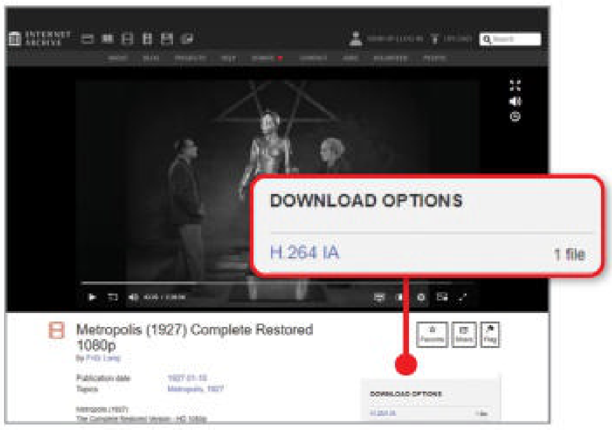
All the content is free to download, unlike Spotify's new Audiobooks section. Why pay the streaming service to hear AA Milne's *Winnie-the-Pooh* (which entered the public domain at the start of 2022) when you can choose from three free versions on LibriVox? The free LibriVox Audio Books app for Android (tinyurl.com/3d8kecyk) and iOS (tinyurl.com/4x3edv9m) lets you browse its library on your phone or tablet, download audiobooks to listen to offline and stream them to a Bluetooth speaker or Chromecast device.

13. Classic films that are now out of copyright

As with books, films that were copyrighted in the US in 1927 will enter the public domain in 2023, so you'll be able to download them for free without fear of prosecution. Some are already available on the Internet Archive and YouTube, although they probably shouldn't be, and the picture quality varies greatly. However, you can expect to see remastered versions appear online over the year, which should delight anyone interested in the history of cinema.



Download free audiobook versions of out-of-copyright titles from LibriVox.



Silent classic *Metropolis* will be legally available to download for free in 2023.

Classic movies that will be legal to download in 2023 include *The Jazz Singer*, the first feature-length film with synchronized sound and spoken dialogue, or 'talkie'. You can watch it now at (archive.org/details/jazzsinger_Title_1). Another cinematic landmark, Fritz Lang's dystopian masterpiece *Metropolis*, will also enter the public domain (or re-enter following a complicated copyright history). Already available to download from the Internet Archive (see screenshot), the 2.5-hour 'complete restored' version (archive.org/details/metropolis.1927.fritz-lang) is the best one to watch. Other films whose copyright expires in 2023 include Alfred Hitchcock's thriller *The Lodger: A Story of the London Fog* (archive.org/details/TheLodgerAStoryOfTheLondonFog_579), Clara Bow in *It* (archive.org/details/it_20190801) and FW Murnau's silent classic *Sunrise* (tinyurl.com/bdfr754w).

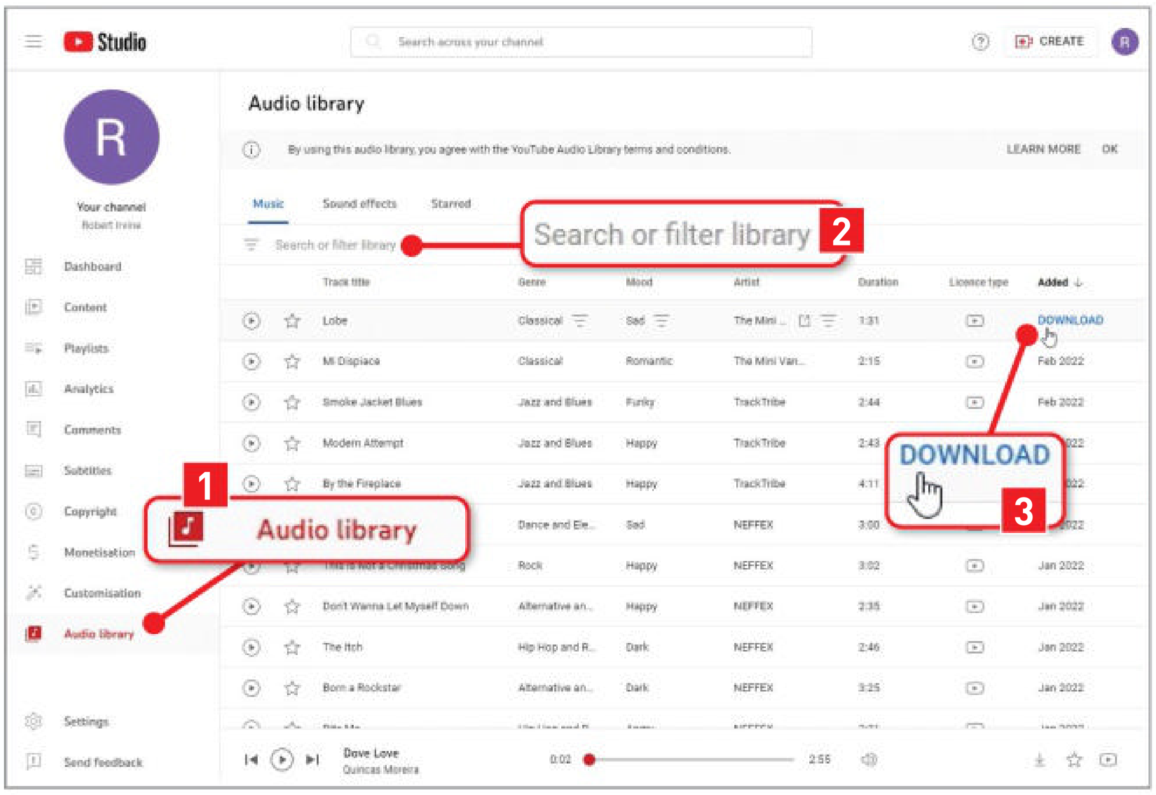
DOWNLOAD FREE AUDIO, PHOTOS & GAMES

14. Royalty-free music and sounds from YouTube

YouTube has announced plans to launch a service called Creator Music in 2023 and is already testing it in the US. This will allow 'creators' to find and license songs for their YouTube videos without having to share their ad revenue with music-copyright holders. It sounds useful for people who earn their livelihood through YouTube, but also means that the rest of us can download free music to use in videos and other projects from the existing YouTube Audio Library.

To access this feature, visit YouTube Studio (studio.youtube.com) and click 'Audio library' on the left (1 in our screenshot above right) to browse nearly 1,750 royalty-free tracks. Click the 'Search or filter library' button 2 to filter the list by genre, mood, and duration, then click the play button to hear a track in your browser. Click 'Download' 3 to save the audio to your PC in MP3 format. Considering that all the music is free, it's good quality and includes classical pieces as well as country and folk, jazz, blues, and much more.

YouTube Audio Library also has a library of hundreds of free sound effects that you can download, each with descriptive names such as 'Toilet flush small bathroom' and 'Tamping soil'.



Track title	Genre	Mood	Artist	Duration	Licence type	Added ↓
Lobe	Classical	Sad	The Mini …	1:31		DOWNLOAD
Mi Dispiace	Classical	Romantic	The Mini Van…	2:15		Feb 2022
Smoke Jacket Blues	Jazz and Blues	Funky	TrackTribe	2:44		Feb 2022
Modern Attempt	Jazz and Blues	Happy	TrackTribe	2:43		022
By the Fireplace	Jazz and Blues	Happy	TrackTribe	4:11		022
	Dance and Ele…	Sad	NEFFEX	3:00		022
This Is Not a Christmas Song	Rock	Happy	NEFFEX	3:02		Jan 2022
Don't Wanna Let Myself Down	Alternative an…	Happy	NEFFEX	2:35		Jan 2022
The Itch	Hip Hop and R…	Dark	NEFFEX	2:46		Jan 2022
Born a Rockstar	Alternative an…	Dark	NEFFEX	3:25		Jan 2022

Download royalty-free music from YouTube's Audio Library to use however you want.

15. High-quality photos and graphics

In November, the stock photo website Dreamstime launched a new 'freemium' plan, which lets you download thousands of high-quality, royalty-free images without paying for a subscription. This makes it ideal for sourcing photos, illustrations, abstract graphics, and more for use in your personal and professional projects.

You will need to sign up for a free Dreamstime account, which rather confusingly asks you to choose a payment plan. Ignore this and head to the Free Photos section (www.dreamstime.com/free-photos). Here, you can download free images with a single click—these are usually in JPEG format with a 300dpi resolution. Dreamstime may ask you to credit the photographer.

Adobe Stock also has a huge collection of free stock photos and graphics (stock.adobe.com). You'll need an Adobe ID to download them.

16. High-resolution copies of famous artworks

Throughout 2022, climate protestors expressed their eco-rage by vandalizing famous works of art in galleries around the world. Ensure you have pristine versions of your favorite paintings by downloading high-res copies from Artvee (artvee.com).

This site lets you browse more than 6,000 artworks from hundreds of notable artists, and save them to your hard drive to use as you please—they're all in the public domain, so you needn't worry about copyright. These include paintings that recently suffered attacks, including Gustav Klimt's *Death and Life*, Johannes Vermeer's *Girl with a Pearl Earring*, and Raphael's *Sistine Madonna*.

It's free to download high-quality images of each work but to get the huge, maximum-resolution versions, you need an Artvee Pro subscription ($8).

17. Free flight simulator

Microsoft recently celebrated the 40th anniversary of its *Flight Simulator* by adding helicopters and gliders, as well as more airports. Although the update is free to install, the full Microsoft *Flight Simulator 40th Anniversary Edition* costs $60 to buy or $10 per month with a PC Game Pass subscription. This may be too expensive for all but the highest fliers, so why not take to the skies for free by downloading FlightGear (www.flightgear.org)?

This amazing open-source flight simulator puts you in the cockpit of hundreds of planes, helicopters, and other aircraft, and lets you fly to and from 40,000 real-world airports. FlightGear is a big download (1.8GB) and its controls take a while to master, but there's plenty of online help (home.flightgear.org/flying) and it was recently updated to make flying smoother than ever.

18. Life-simulation game The Sims 4

Even if you don't play video games, you are probably familiar with *The Sims*, the popular 'life-simulation' game in which you create a virtual character, build and furnish a house, then explore your 3D environment and interact with other characters. In October, the game's developer, EA, made the latest version (*The Sims 4*) free to download on computers and consoles—it previously cost $25 and still does on Amazon.

There are two ways to download *The Sims 4* to your PC in 2023. The easiest is to install EA's desktop app (www.ea.com/ea-app), create a free account, and then find the game—it should be on the home screen under 'Top games'. Click 'Download' to save *The Sims 4* to your hard drive—though note that it requires nearly 20GB of free space.

Alternatively, you can download it, and other free titles, by installing the Steam app (store.steampowered.com). Although *The Sims 4* is now free, you need to pay for add-ons to get extra items and skills.

Will Windows 11 remain free in 2023?

It's currently free to upgrade to Windows 11 and has been since it launched in October 2021. But it's possible that Microsoft may start charging users for the new operating system in 2023.

Windows 10 was available as a free download for its first year of release, but from July 2016, it cost around $120 to upgrade from Windows 7 or 8.1. It has now been nearly 15 months since Windows 11 arrived and Microsoft has yet to confirm whether the free offer will end. In the 'Frequently asked questions' section of the 'How to get Windows 11' site (www.microsoft.com/en-us/windows), it states only that "the free upgrade offer does not have a specific end date", but that it "reserves the right to eventually end support for the free offer".

Windows 11 is likely to remain free for the time being because uptake has been slow—so far, only around 15 percent of PC users have upgraded. In comparison, around 25 percent had moved to Windows 10 in the same period. Charging for an operating system that people are unwilling or unable to install would be bad business sense, especially during a cost-of-living crisis. We predict Windows 11 will remain free until at least its two-year anniversary in October and possibly for good if Microsoft launches Windows 12 in 2024.

CENTERFOLD

Elgato Stream Deck+

WE ALL KNOW that a cluttered desk can be the sign of a cluttered mind, so the idea of adding yet another peripheral to your workspace might appear to only further compromise your efficiency. But this charming little device from Elgato aims to do just the opposite. Taking what was already great about the previous Stream Decks, the Plus variant adds a touch panel and four customizable dials for even more fine-tuning than before.

The main purpose of the Stream Deck+ is that it's essentially a cheat code for your PC. Consider it the ultimate shortcut device, in which you can access applications, create macro buttons, change settings, and launch commands—all on the fly and without leaving your current app. This not only makes it perfect for streamers (the clue's in the name) but also for designers, developers, and gamers—you name it and there will be a way in which you can use the Stream Deck+ to make your life easier.

Setting up the Stream Deck+ takes some time, depending on what you use it for, of course, but this will inevitably save you so much time and effort and ultimately streamline your experience. With its new control options, the new Elgato Stream Deck+ is the greatest evolution of this tool yet. It's also cheaper than the current XL version at $200, so it's pretty much a no-brainer. –SAM LEWIS

1 A WINDOW OF OPPORTUNITY

The Stream Deck Plus features a 4-inch touch display bar, allowing you to swipe between pages set up on the Elgato Stream Deck app, which alters what the top eight macro buttons show. For example, you could have a page on streaming functions, one for productivity, and another for shortcuts. Its main focus is showing what functions are assigned to the dials below it. You can also touch the screen to activate these assigned functions.

2 DIALING IN NEW FUNCTIONALITY

The 4-inch touch display isn't the only new trick Elgato has up its sleeve. The Plus model also has four new 360-degree dials, which offer much greater accuracy of control. These dials are arguably the biggest appeal for new users—streamers, for example, will be able to adapt volume mixers promptly here for quick changes. The dials feel great to the touch and they not only offer extra functionality but can be pressed in for even more options.

3 IF IT AIN'T BROKE, DON'T FIX IT!

Of course, it wouldn't be a Stream Deck without the eight LCD macro keys. Using the Elgato Stream Deck app, these can be fine-tuned to a multitude of tasks, and you can also virtually create pages for different scenarios, using the touch screen to swipe between them. The ability to customize the switches to suit your setup makes the possibilities almost endless. If you need to boost productivity and efficiency, the Stream Deck+ is the perfect all-in-one controller.

STREAM DECK
elgato

The motherboard is the foundation of every PC but how well do you know this complicated component? *Darien Graham-Smith* explores all its main features

THE MOTHERBOARD MAP

1 Chipset

The chipset is a collection of controller chips that manage the flow of data between the CPU and other components. It might be hidden under a heatsink, as in the image opposite, but it's present on every board. Different chipsets support different processors: Intel's 13th generation Core processors can only be used in a board that uses one of the company's 600-series or 700-series chipsets, while AMD's Ryzen 7000-series CPUs need an AMD B650 or X670 chipset.

The chipset doesn't just determine what CPU you can use. It also dictates other technical features of the motherboard, such as whether it works with DDR4 memory or requires more expensive DDR5 modules, and how many PCI-Express lanes and USB connectors it has. You don't have to research the technical details of the chipset before buying a PC, though—you can just check the features of the board itself.

2 CPU socket

Intel's 12th and 13th-generation desktop processors use the LGA1700 socket format. The letters stand for 'land grid array', meaning the socket contains 1,700 tiny pins, which press against a grid of flat contact points on the base of the processor. Installing the CPU in a socket like this is a simple case of dropping the chip into the housing and locking it in place with a latch.

For AMD's Ryzen 7000-series processors, the socket AM5 connector is an almost identical LGA design, with 1,718 pins. Older Ryzen CPUs use PGA (pin grid array) sockets, where the motherboard mount has thousands of tiny holes and the pins stick out of the underside of the chip. The two designs are electronically identical but PGA is more fiddly and it's easier to bend or break the pins.

3 RAM slots

Some motherboards use DDR4 RAM, while others require the newer, faster, and more expensive DDR5 modules. These technologies aren't cross-compatible, and a little plastic key that sticks up near the center of the slot ensures that you can't accidentally plug in a module of the wrong type.

You'll often see memory slots in colored pairs. This is for dual-channel configurations: if you put two identical DIMMs into matching slots, the motherboard can boost performance by accessing them in parallel. Dual-channel memory is optional, however—you can put any DIMM of any size into any slot. You can also mix modules with different speed ratings, although they will all uniformly operate at whatever frequency is set in the BIOS.

4 CPU power connector

Most CPUs draw less than 20W when sitting idle, but their demands can instantly rocket when you fire up a heavyweight workload. Ryzen 7000 processors can demand up to 230W with all cores active, while the Intel 19-13900K goes as high as 250W.

To ensure that the CPU gets all the power it needs, the motherboard provides one or two dedicated 12V power sockets, fed directly from the main power supply. A single eight-pin power connector can deliver up to 288W, so you don't normally need to connect a second socket unless you're planning to overclock. There's no harm in doing so, though—the CPU won't draw more power than it needs.

5 Motherboard power connector

The standard power plug on an ATX power supply has 24 pins, which deliver multiple power feeds at 3.3V, 5V, and 12V, to drive various components integrated into the motherboard. Some of the pin housings are square while others have angled sides, so it's impossible to plug the power connector in the wrong way round. There is also a plastic clip that holds it in place once it's correctly inserted.

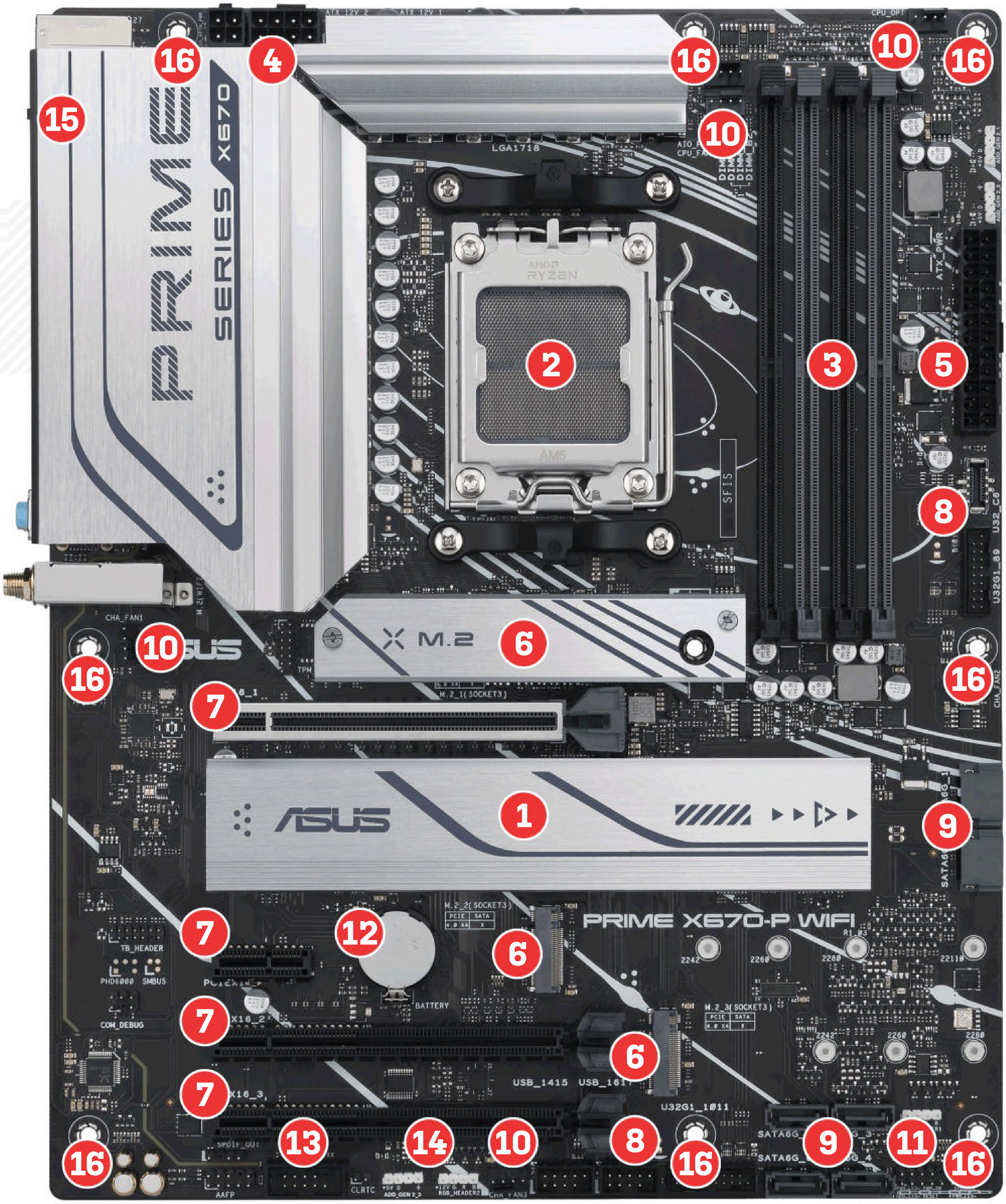
The power plug is sometimes split into two, with the last four pins detached from the rest—this is to enable compatibility with older motherboards that use a 20-pin socket. A plastic lip lets you connect the two sections into a standard 24-pin plug and holds both parts in place once the plug is fully inserted.

6 M.2 slot

Any modern motherboard will offer at least one SSD slot in the 22mm M.2 format. For example, the Asus Prime X670-P WiFi in our image has three slots, with a heatsink over the first. It's questionable how necessary that is, however: an overheating SSD can lead to errors and crashes, but any drive that needs a heatsink to work reliably should come with one attached.

M.2 supports both the NVMe and SATA standards, but you'll rarely see a SATA drive in this format because NVMe is far faster. Just how much faster depends on the PCI Express version used by your slot and your drive—if the motherboard and SSD both support PCI-E 5, you could see transfer rates as high as 13GB per second. But that's for the future. For now, PCI-E 4's bandwidth of around 8GB per second is plenty, and Gen4 SSDs (as they're often called) can't saturate it.

To the side of the M.2 slots, you'll see a row of screw holes, which can be used to fit drives of various standard lengths. In practice, most M.2 drives use the 2280 format (22mm wide x 80mm long) and are secured with a single screw 80mm away from the slot.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M.2

7 PCI-E slots

PCI Express slots come in three different standard sizes—x1 (25mm), x4 (39mm), and x16 (89mm). You can actually install a card of any size in any slot: an x1 card will work in an x4 or x16 slot, and many boards have open-ended connectors that let you plug an x16 card into a shorter slot. This is likely to limit the card's performance, however. As the name implies, an x4 slot has only a quarter of the bandwidth of x16.

As with M.2 slots, the actual speed of each slot depends on the PCI-E generation. The latest PCI-E 5.0 standard is twice as fast as 4.0, with the ability to transfer 64GB/sec over a full-sized x16 slot. AMD's upcoming Radeon RX 7900-series GPUs are set to be the first cards that can take full advantage of that enormous speed.

8 USB header

In addition to the USB sockets on the rear panel (see sidebar opposite), most PC cases have a few additional sockets at the front or side. For these to work, they need to be connected to USB headers on the motherboard.

These come in various designs, to suit different types of USB ports: a basic USB 2 port uses a nine-pin connector, while a USB 3.2 port requires a specific 20-pin plug. Each header can drive two external USB ports—if your board has any spare headers, you can make use of them by investing in a cheap backplate that adds extra USB sockets to the rear of the case.

9 SATA connectors

M.2 SSDs are fast but SATA drives are much better value for bulk data storage. It's also an easy technology to get along with since all SATA ports use the same connectors and run at the same speed (6Gbits/sec). Some boards offer two sets of ports pointing in different directions, but this is just to suit different case layouts. If you want more SATA ports than your board offers, you can add more via a PCI-E card.

On high-end boards, there may be a specific group of SATA ports that can work together as a RAID array, configured via the BIOS. In the absence of this feature, you can use Windows' Storage Spaces feature to create a pooled virtual drive from any set of disks, or fit a dedicated SATA RAID controller card.

10 Fan connectors

Somewhere near the CPU socket, you'll find a header for plugging in the CPU fan. This isn't optional: if the processor overheats, the whole system will run slowly or crash. However, it's up to you whether you make use of the other fan headers dotted about the board. Outside of enthusiast builds, case fans are unlikely to make a noticeable difference to performance or stability.

Many boards offer a mix of three- and four-pin fan headers. You can plug any fan into any header, but using a four-pin fan with a four-pin header allows you to manage the fan's speed from the BIOS or a companion app. Typically, you might set your fans to run slowly and quietly most of the time, then automatically speed up if the motherboard temperature exceeds a certain threshold.

11 Front panel connector

The front panel connector looks like a regular header, with 15 bare pins sticking up from the motherboard. However, it doesn't connect to a single cable, but to a collection of little two- and three-pin plugs that dangle inside the PC case. These plugs make the power button, reset button, power LED and hard disk LED work, as well as the loudspeaker that beeps when you power on or reset the system. There's no standard layout for front panel connectors, so if you're assembling a PC, you may need to refer to the manual to work out which plug goes where. Occasionally, the details may be printed directly on the board, as in our example image.

12 Battery

A few decades ago, motherboards used to feature a small cache of battery-powered memory, so that BIOS settings would be remembered even when the computer was unplugged from the mains. Today's boards use flash memory, so the battery is no longer needed for that purpose, but most motherboards still include a CR2032 battery, just so they can keep track of the date and time when there's no power. Since most desktop PCs are kept permanently plugged in, this battery can easily last for more than five years, but if your desktop remains in service long enough, the battery will eventually need replacing.

13 COM header

The RS-232 serial interface is a relic of the dial-up era: with a maximum speed of 115Kbits/sec, it's about 0.0006 percent as fast as a modern USB connection. Unsurprisingly, it has been a long time since we've seen a motherboard with an old-fashioned nine-pin serial socket on the rear panel.

Yet serial connections do still have a role to play in certain industrial and scientific settings, controlling custom machinery that might have been designed 40 years ago. The COM header lets you attach a backplate with a serial connector so that the latest boards can be integrated into legacy workflows.

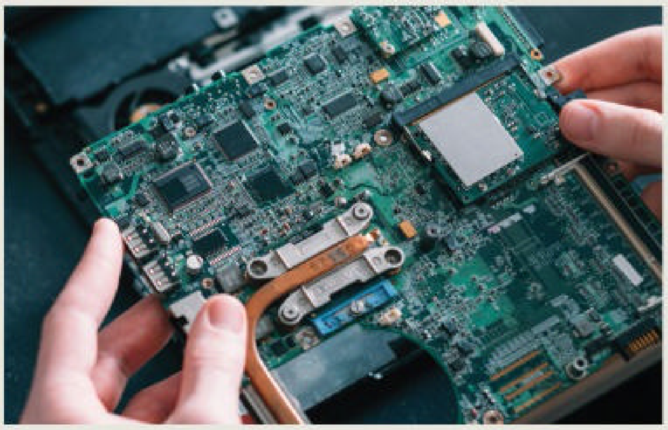
14 RGB header

While there's no universal standard for RGB lighting and accessories, many motherboards offer connectors that can power LEDs, and let you control their color patterns via the BIOS or a dedicated app. Be warned, though: three-pin ARGB connectors put out 5V on the first pin, while the older four-pin RGB standard supplies 12V, so don't push a three-pin plug onto a four-pin header.

15 LED readout

Some motherboards have an LED screen that shows a series of cryptic numbers while the PC is starting up and running. Decoded, these numbers tell you what the BIOS is doing at any given moment—or what error it has

WHAT ABOUT LAPTOPS?

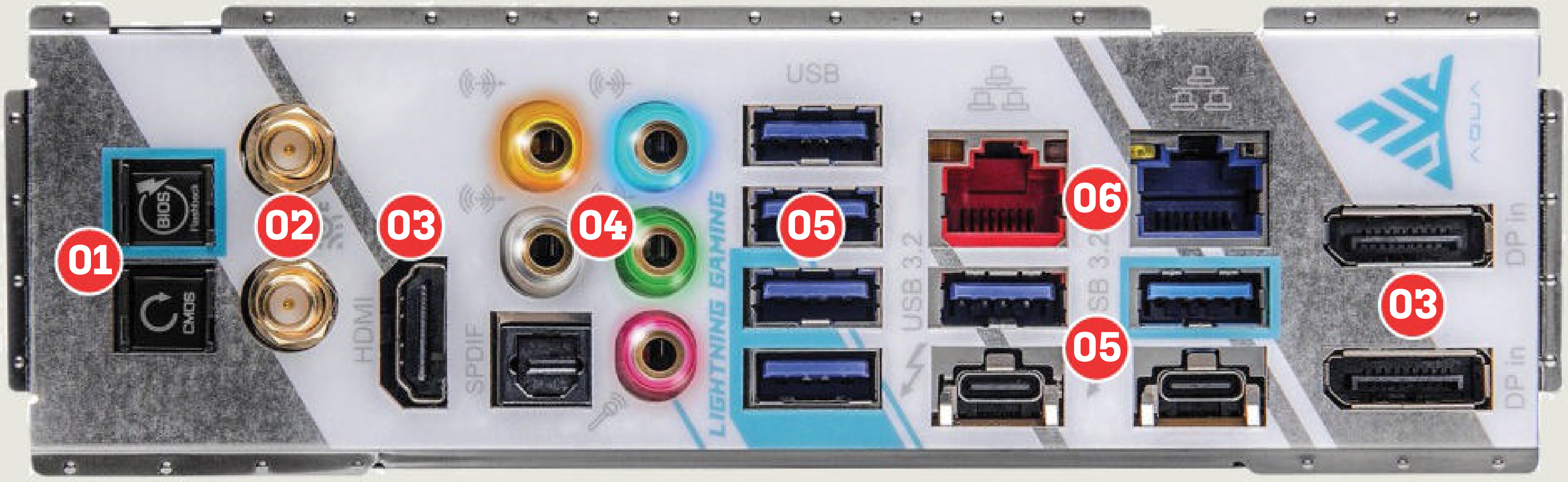


Laptops focus on minimalism

Inside every laptop, there's a motherboard that does the same basic job as a desktop board. However, laptops are more minimally designed, with a focus on minimizing weight, size, and power consumption. Unscrew the casing from your laptop and it's unlikely you'll find any internal headers or expansion slots—the memory is often soldered in place.

You'll see fewer chips, too, as CPU manufacturers seek to maximize efficiency by building multiple components into one physical package. Alongside the CPU cores, a mobile processor might contain memory, storage, and networking controllers, so there's no need for a separate chipset—it's all bundled into one system-on-a-chip.

An example of SoC design is the Apple Silicon architecture, used for the company's M1 and M2 processors. These not only combine CPU and chipset functions, but they also have all the system RAM built into the chip. This makes memory upgrades impossible but allows the CPU to access data at extremely high rates. Meanwhile, the motherboard becomes much less important.



THE REAR PANEL

EVERY MOTHERBOARD OFFERS A VARIETY OF CONNECTORS AND PORTS AT THE REAR. HOWEVER, IT'S RARE THAT ANY TWO BOARDS OFFER THE SAME SELECTION OF SOCKETS, SO IT'S WORTH INVESTIGATING WHAT'S THERE

01. BIOS buttons
If you like to tinker with your BIOS, you could accidentally get into a situation where the computer can't start up. Enthusiast boards often offer handy buttons that reset your system to default settings or recover a backed-up configuration. Without these, the only way to undo a configuration error might be to open up the PC and press a button on the motherboard—or set a jumper.

02. Wireless antenna connectors
If your board has built-in Wi-Fi, the backplate should include two screw-in antenna connectors. A small aerial unit is normally included in the box, and this will work fine for the average home. If you want the very best reception, you can replace this with any antenna assembly that uses the standard 3.5mm TS-9 connector.

03. Video Connectors
If you're using a PCI-E graphics card then you can normally ignore these—the card will have its own ports. However, for integrated CPU graphics, you'll want an HDMI or DisplayPort output socket. It's possible to run video over a USB Type-C connector, but that's unusual in desktop boards. Older DVI or VGA connectors can also be useful for projectors or other legacy displays.

04. Audio jacks
Most motherboards have built-in audio hardware—the number of sockets at the back determines whether you're limited to basic stereo or whether you can take advantage of 5.1 or 7.1 surround sound. An S/PDIF connector lets you connect your PC to an AV receiver or other digital-compatible destination, for the best possible sound quality.

05. USB ports
There's a confusing range of USB standards currently in use. Many boards offer a mixture of ports rated at 5Gbits/sec and 10Gbits/sec, while some go up to 20Gbits/sec. Different speeds are sometimes indicated by differently colored ports, but there's no consistency to this. You'll likely see a mix of Type-A and Type-C sockets too, but this isn't a big deal—with a cheap converter plug or cable you can connect any USB device to any socket.

06. Network ports
Most motherboards offer one Gigabit Ethernet port; some have two, which can be aggregated to create a 2Gbits/sec link. Native multi-Gigabit Ethernet is also becoming common: the ASRock Z690 Aqua (pictured) has one 2.5GbE connector and one 10GbE port. If your board doesn't have the connector you want, you can buy a USB 2.5GbE or 5GbE adapter quite cheaply. 10GbE can be added via a PCI-E card.

07. Legacy ports
(not pictured)
Other connectors you might see include a nine-pin serial port (see above), a round six-pin PS/2 connector for a keyboard or mouse, a 25-pin parallel port for old printers, and a flat eSATA connector—from the days when SATA was the fastest way to connect an external drive. If you don't recognize these connectors, you don't need them. They won't do any harm, but they do take up space that could be used for more modern connectors.

encountered. For example, if the computer won't start, the code might indicate whether the problem happened while initializing the CPU, memory, graphics card, or SSD. This might be useful information to an enthusiast system builder, but the latest UEFI BIOS systems can often provide useful messages on the screen in plain English.

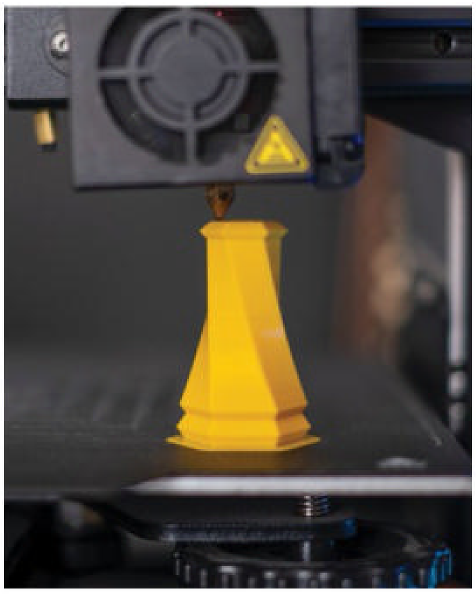
16 Screw holes

The screw holes in a motherboard aren't exactly hi-tech, but they're still important: they determine which cases the board can be installed in. The ATX format, originated by Intel in 1995, defines a size of 305 x 244mm, with nine screw holes in specific locations around the edge and one near the middle.

Most ATX cases can take a microATX board (244x244mm). If the case doesn't have microATX fittings, seven of the nine hole locations are the same, which is enough to hold the board in place securely. If you are building a PC using a different format, such as FlexATX (229x191mm) or mini-ITX (170x170mm), check the case mountings are a match for the board.

3D PRINTING comes of age

Whatever happened to the 3D-printing revolution? **Nik Rawlinson** takes a fresh look at the much-maligned technology and finds that the hardware has come a long way



3D models are printed as a series of layers.

3D printing used to be the next big thing—but then it seemed that the bubble had burst. Early adopters struggled with unreliable hardware and clanky software tools. A 2013 feature in the UK newspaper *The Independent* asked, "How hard can 3D printing really be?" before concluding it could be "Quite hard". Even trying out the technology for yourself was expensive and fiddly—the printer tested for that article cost $1,700, and required self-assembly.

But things are rapidly improving. "Even five years ago, the market was very hobbyish," says Craig Monk of UK-based 3D Print Monkey (3dprintmonkey.co.uk). "The machines would be built from parts you'd sourced yourself, as opposed to buying a machine with injection-molded parts, a decent user interface, and those sorts of things. Where we are now, we were dreaming about ten years ago. It's a lot more user-friendly, for the beginner and professional alike."

Prices have tumbled, too. Today you can pick up a lightweight 3D printer, such as the Easythreed Nano Plus for a little over $100, or the larger Etina Tina 2 for around $80 more. The actual printing material itself can be bought for around $20 per kilogram, so you can print a phone case for about a dollar, so long as it's not too complex.

Buying materials

Most consumer printers use a process called fused deposition modeling (FDM). A plastic filament is fed into the heated print head, where it's melted and squirted onto the print bed to set in a particular pattern. Then, the print bed moves down a tiny distance (or the print head moves up), and the next layer of the item is laid down, and so forth.

Early printers normally used either strong polylactic acid (PLA) filament or lighter acrylonitrile butadiene styrene (ABS). Today, there are more options: some are tough, rigid, and flame-resistant, while others are flexible and rubber-like. A mid-range 3D printer may be able to switch between materials as it prints, to produce complex models (or 'parts') that combine different colors, textures, and physical properties. With a cheaper single-material printer, you need to load up the right materials to print each section individually, and manually assemble them at the end of the process.

As an alternative to the FDM process, stereolithography (SLA) printers are growing in popularity. Rather than melting a spool of plastic, SLA uses a laser to harden liquid resin into the desired shape. The SLA process is more technically complex than FDM, but it can produce more finely detailed objects with greater reliability.

Resin is also more versatile when it comes to fine-tuning the appearance of your parts. "When you buy filament, let's say you choose red PETG, for the strength and that specific color. That spool will always be red PETG," Monk explains. "But resin is much more versatile. You can start with a standard resin and make it more flexible by mixing it with a flexible resin. If you don't like the shade, you can add in a bit of black or white. You can change the resin to suit you."

Downloading and designing parts

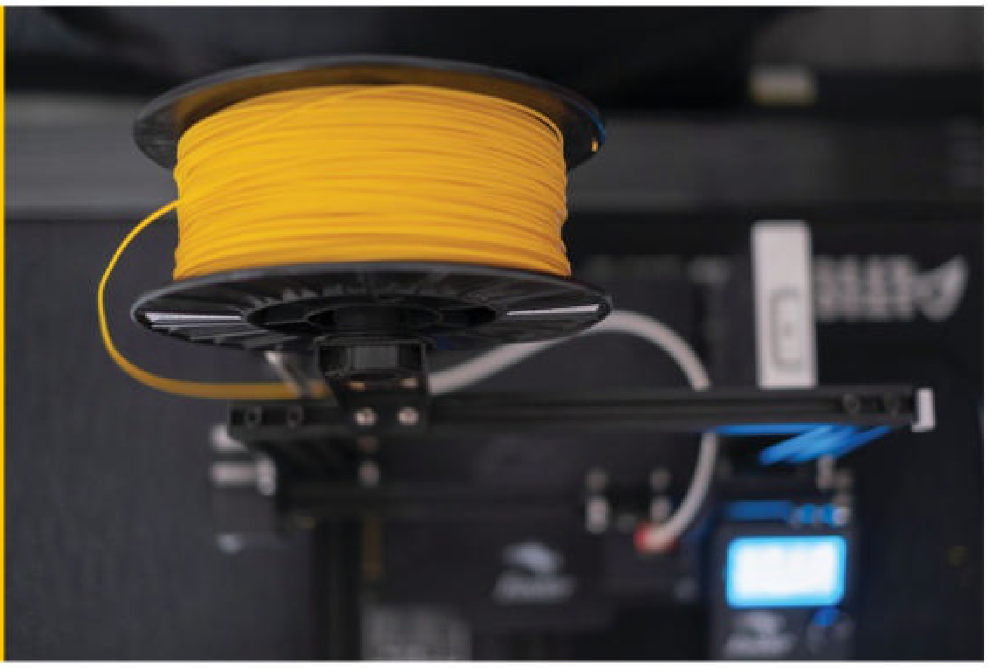
If you want to print your own custom parts, the difficult bit isn't the printing itself—it's assembling 3D models of the shapes you want to produce. Thankfully, there are now huge online libraries of freely downloadable templates to draw upon, in the widely adopted STL format.

Ultimaker
aker

There is a wide variety of parts available for free download.

This standardization also gives you plenty of freedom when it comes to creating or tweaking 3D designs. In the past, you might have been stuck with whatever software came bundled with the printer, but now you can use industry-standard tools such as Blender (blender.org), Meshmixer (meshmixer.com), or SketchUp (sketchup.com) to edit your models or even create your own from scratch.

There's a choice of tools for slicing too—that is, preparing a 3D model for the printing process. Cura, from 3D printer manufacturer UltiMaker (ultimaker.com), is one free option and its rival Slic3r (slic3r.org) is another popular choice.



Most consumer devices use spool-based material.

What can I print?

3D printers come in all shapes and sizes: larger printers can generally produce larger items in a single

© UNSPLASH, OSMAN TALHA DIKYAR AND TOM CLAES

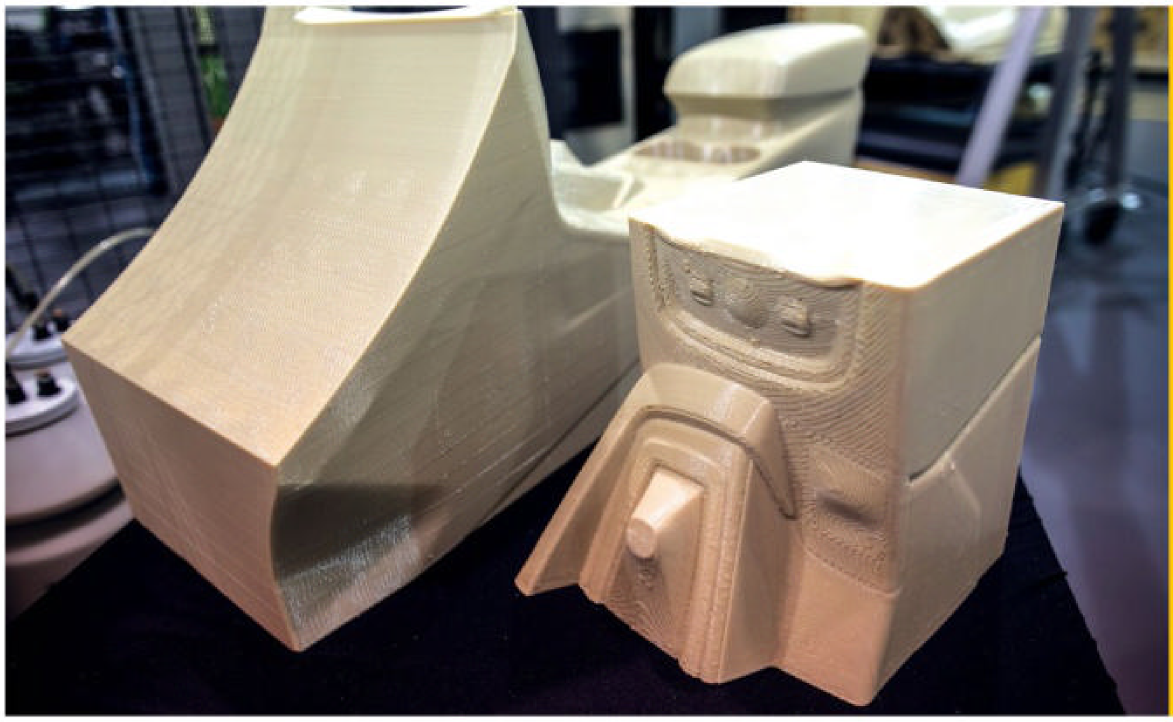
operation. Even so, outside of industrial settings, few 3D printers can produce models much more than 30cm in any direction.

That doesn't mean you can't print something large—you'll just have to break the model down into smaller parts, print them in sequence, and glue or slot them together by hand. For your first few projects, we'd recommend that you stick within the bounds of the build chamber, at least until you get familiar with the printing system.

Repair a vintage car

One community that has benefited enormously from 3D printing is vintage car enthusiasts. When a vehicle has been out of production for many decades, it can be impossible to source spare parts; many owners resort to cannibalizing old cars sent to scrap, or scouring auction sites and jumble stalls.

But with 3D printing, small parts such as clips, supports, bulb coverings, levers, and switches can be cheaply and quickly produced at home. Materials such as MakerBot Tough have twice the impact strength of ABS, so they're ideal for snap-fit assemblies, while chemical-resistant PETG materials are suitable for reservoirs and other containers for liquids. Nylon material that withstands rubbing can be used for buffers that sit between adjacent surfaces that would otherwise come into contact.


Ford Motor Co. is exploring how large car parts could be printed.

You don't even need to own a 3D printer to benefit. Using a consumer 3D printing bureau to print custom parts is almost always cheaper and quicker than researching and ordering authentic parts.

As it happens, the automotive industry was one of the earliest adopters of 3D-printing technology. Back in the 1980s, the third SLA printer ever produced was purchased by the Ford Motor Company. 3D printing is primarily used for prototyping and building sample parts: "Where it would have taken four to five months and cost $500,000 to produce a prototype with traditional methods, a 3D printed part can be produced in a matter of days or hours at a cost of a few thousand dollars", the company notes on its website.

Produce a phone amplifier

An easy 3D-printing project is a passive phone amplifier, where the phone slots into a holder with a shaped aperture that amplifies the speakers' output. Indeed, it's a lot easier than it used to be: many designs, such as the snail-like Sound amplifier v2 (www.thingiverse.com/thing:3043064), need to be printed with extra support material so they don't fall over during the printing process. With an older printer, this would need to be snapped or cut away after printing was completed, but with a modern multi-material printer, you can use water-soluble support material such as Ultimaker PVA, which disappears under running water. It's 100 percent biodegradable with no hazardous by-products, so you can simply wash it away down the sink.

You can take advantage of increasingly sophisticated projects that combine 3D builds with custom circuitry. Thingiverse user e&h Design (guppyk2) has produced several attractive speaker enclosures, including a 4-in desktop model (above) that can be used with a Bluetooth connection (www.thingiverse.com/thing:4750820). To create the finished product, you simply need to buy around $25 worth of widely available electronics.

Add a few electronics and you can print an attractive speaker.

Print a pen plotter—or plot with your printer

You can buy a dedicated plotter for large-scale data-based graphics for between around $150 and $500 or you can make your own, using a 3D printer and an Arduino microcontroller board. Designer Henry Arnold estimates that his DrawBot 1.1 project will cost around $100 to produce, and it can hold a variety of drawing and writing implements that make it suitable for all sorts of jobs.

It's even possible to turn your 3D printer itself into a plotter by printing out a pen holder, and then attaching this in place of the extrusion head. The pltr V2 Toolhead is designed to convert a Creality Ender 3 Pro or Ender 3 V2 printer in just this way (see YouTube for some handy videos on getting started).

Plotter enthusiasts should also be aware of the BrachioGraph. While this doesn't involve a 3D printer, it is the cheapest plotter you can build, constructed from foldback clips, lollipop sticks, clothes pegs, a pen, and a Raspberry Pi Zero.

Experiment with old-school photography

Medium-format photography can be an expensive hobby, but Printables user Javier Fernandez has developed a printed camera body that works with Mamiya Press lenses. You can use a ratchet wrench to advance the film or take advantage of a remix that uses solely 3D-printed internals.

If you want to create a camera entirely from scratch, that's possible too. Thingiverse user Todd Schlemmer has created a range of printable pinhole cameras that don't need a separate lens. One of them uses classic 120 medium-format film to produce images with a characteristically wide field of view.

If it's not too recursive, you can also use a 3D printer to produce a mount for a camera to watch your 3D printer. This can be useful if you're producing a large print job and want to monitor it remotely to ensure nothing's gone wrong. Sneaks, on Printables, has produced a model for the Prusa Mk2 and Mk3 that can be used to hold a Raspberry Pi camera in place, capturing either stills or a live feed, which can then be shared or broadcast online using a simple Python script.

More ambitious builds—a wind turbine or tape player?

Want to cut your energy bills? UK-based Daniel Davis has designed several printable wind turbines: the Mk III can produce an output of 50W and charge a battery in wind speeds as low as 5m per second. It's part of an extensible system, so it can be adapted for higher power output in the future.

Or, if you fancy trying your hand at DIY DNA extraction, Food Lab Thailand has designed a 3D-printed centrifuge that uses a motor salvaged from a drone, an Arduino Nano, and other commonly sourced parts. "We are currently using it for DNA extraction," the lab explains. "Just by building it, you can learn a lot about how it works and perhaps get inspiration to design your own lab equipment in the future (and hopefully share it with others!)."

Or how about printing a retro 'tape player'? It actually plays MP3s instead of old magnetic tapes. The parts list is fairly extensive, including switches, buttons, an IPS TFT display, and an Adafruit Feather board, but the result looks great. You can download the STL files from the Learn Adafruit website (learn.adafruit.com), where you'll find a full list of components and direct links to buy them.

The sound amplifier has an organic, snail-like appearance.

The barriers are lowered and the sky's the limit

These projects perhaps undersell how far 3D-printing technology has really come along in the past few years. Most of these builds would have been technically achievable with the first generation of 3D printers, but the process would have been comparatively fiddly and unreliable—not to mention far more expensive.

"3D printing is becoming more reliable, cheaper, and easier," says Monk of 3D Print Monkey. "Many of the barriers to entry have gotten so much lower. It's constantly getting better. It's a lot more user-friendly than it ever was."

So, if you're thinking it's time to take another look at 3D printing, Monk's current recommendations for home printers include the Elegoo Mars 3 Pro (around $360) and Saturn 2 (around $650). Both are MSLA devices. For a cheaper option, the FDM-based Creality Ender 3 V2 can be found for $260.

"I would expect a total novice could have that up and running—perhaps not printing, but at least running the calibration test—within an hour," says Monk.

While we haven't quite reached the point of having a 3D printer in every home, the technology is becoming ever more attainable—and you no longer need the patience of a saint or the expertise of a dedicated enthusiast to get attractive and useful results.

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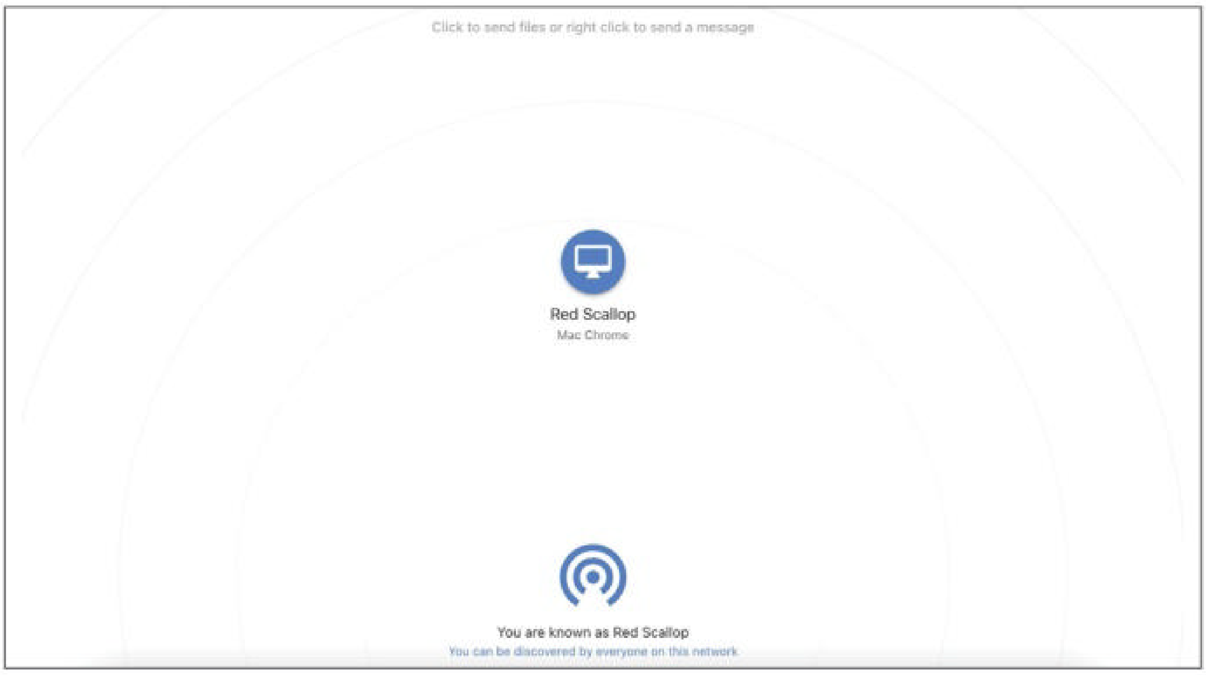
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

TIP OF THE MONTH



Click to send files or right click to send a message

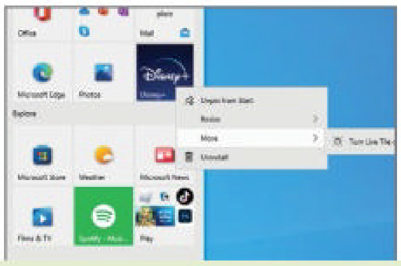
Red Scallop
Mac Chrome

You are known as Red Scallop
You can be discovered by everyone on this network

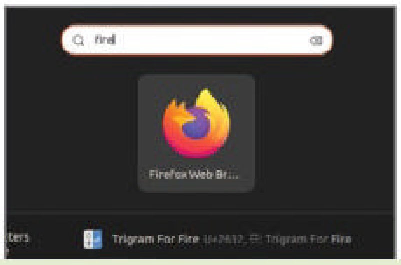
SNAPDROP

Anyone who's ever used AirDrop on macOS or iOS will know just what a useful tool it is for sharing photos or documents quickly between two compatible devices. But did you know Snapdrop offers an almost identical experience on all sorts of devices? Go to Snapdrop.net to start receiving and sending files between Windows, Android, iOS, and macOS. It's simple and your files are sent using WebRTC, so they're encrypted.

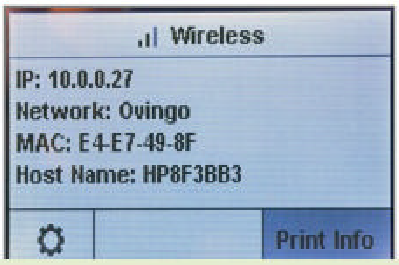
MAKE – USE – CREATE



64
How to block adverts in Windows 10 or 11.



66
Go incognito by running Linux in a virtual machine.



IP: 10.0.0.27
Network: Ovingo
MAC: E4-E7-49-8F
Host Name: HP8F3BB3

68
How to prevent your printer from being hacked.

© SNAPDROP.NET, MICROSOFT, WWW.VIRTUALBOX.ORG, HP

↘ submit your How To project idea to: editor@maximumpc.com

SAM LEWIS
STAFF WRITER

JUST A SMALL REJIG

Is it just me, or does everyone's desk or workspace inexplicably become messier over time, even though you're simply sitting and clicking buttons all day? It's a widespread mystery in the tech world, with a multitude of conspiracy theories surrounding this bizarre phenomenon—I'm sure there will be many of you out there who sympathize with me.

I finally decided to tackle this head-on and spent a day cable managing, cleaning, reorganizing, and moving my setup. A messy room creates a messy mind and although at the time this wasn't the most thrilling of tasks, it was necessary. So, if you're currently looking at a messy desk, give it a spruce up and see how much it improves your workflow, as it has certainly improved mine.

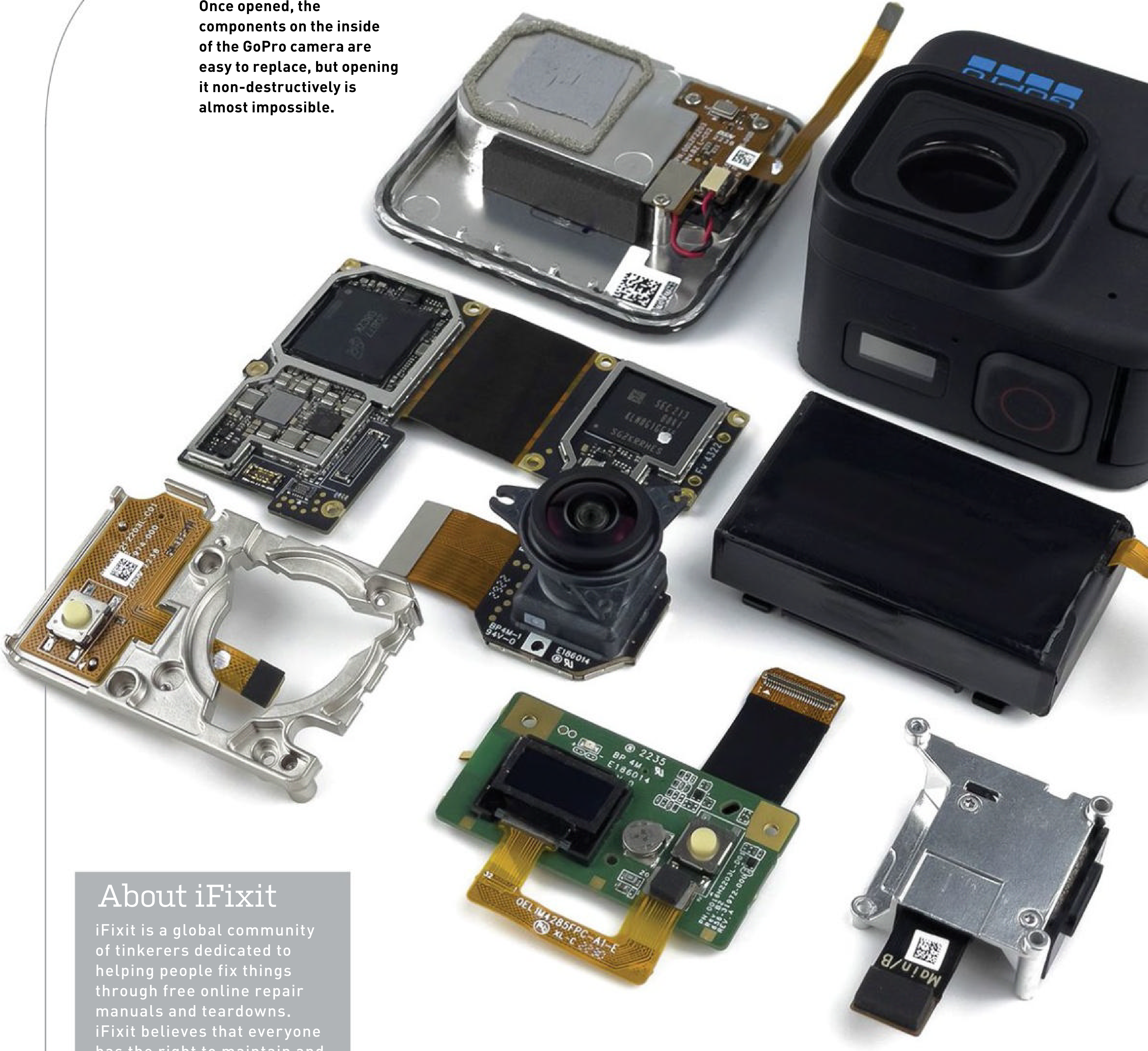
Of course, I then used my newly cleaned setup to play through *A Plague Tail: Requiem*, which I thoroughly enjoyed from start to finish. I loved the original *A Plague Tail: Innocence* released in 2019, so I was excited about this and even more so because it was on Xbox Game Pass. Unlike many games I'd looked forward to recently, it blew me away with its gripping storyline and stunning graphics. All in all, it was a great use of my refreshed office space, though doing some actual work may have been more practical.

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

Once opened, the components on the inside of the GoPro camera are easy to replace, but opening it non-destructively is almost impossible.

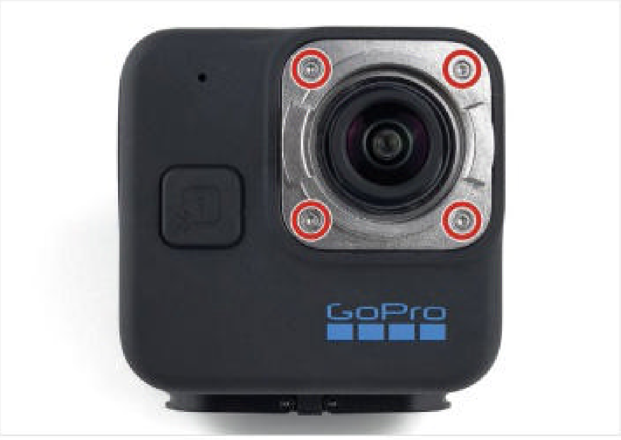


About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com

The HERO11 Black's Mini-Me gives off a 'back to the roots' vibe—no display for live preview whatsoever. Just a rugged little camera, ready to take a beating.

GoPro HERO11 Black Mini



There are four T4 Torx screws under the lens cover. Sadly, removing them doesn't offer much of a way into the camera.

Heat usually works but when your opponent is a literal heatsink, things get difficult. Only a trusty dremel tool can save the day.

As promised by GoPro, it's the same lens and sensor that the company uses in its full-sized HERO11 Black.

BACKGROUND

In 2022, GoPro released the HERO11 Black and HERO11 Black Mini. With up to 5.3k 60fps and built-in HyperSmooth video stabilization, the Mini has similar hardware features to its bigger sibling. So, let's look at the inner workings that make this new form possible!

MAJOR TECH SPECS

- GoPro's GP2 processor for image processing and stabilization
- 27.6MP 8:7 1/1.9in sensor with ultra-wide angle lens (ƒ/2.5)
- High-res video. Up to 5.3k @60fps and 2.7k @240fps for slow-mo
- 0.5in 72x32px OLED status display
- Waterproof up to 10m
- 133g (21g lighter than the bigger HERO11 Black)

KEY FINDINGS

- A look under the hood reveals an internal battery, a USB-C port to charge it, and a microSD slot. The lens cover twists right off. Flipping up the Folding Fingers uncovers eight T5 Torx screws. Underneath, there are two more T5 Torx screws but they don't provide access to the GoPro's insides. Sigh!

- All screws come out, but nothing moves, so there must be glue. We use a Dremel and the heatsink lifts off like it was never attached in the first place. Victory at last!

- Three Phillips #000 screws are loosened to remove the flexible circuit board (FPC) from the heatsink. Underneath sits the speaker for the camera's sound. Located between two mounting holes is the GoPro's rear-facing MEMS microphone.

- The battery can now be unplugged. After that, it takes just one T4 Torx screw to loosen the battery tray and pull the 1500mAh Li-Ion cell out of the case. An internal battery for a camera that is virtually impossible to open non-destructively? Not nice!

- To free the mainboard, we unplug the connector for the sensor and remove the four Phillips screws, only to find it's a rigid-flex PCB and realize that the other part is buried even deeper.

- After peeling back some tape, there's one more Phillips #000 screw and the USB port assembly can be pulled out of the body. With the mainboard unobstructed, it reveals that the MicroSD slot is soldered directly to the second part of the mainboard.

- With the connectors unclipped, removing the FPC uncovers a Phillips #000 screw and the mainboard is freed. We unclip the EMI shields and remove the thermal paste to see a GoPro GP2 processor, Samsung 8GB eMMC memory, Qorvo power management, a microSD connector, and an STM microcontroller.

- Next up is unclipping the sensor's EMI shield, removing some tape and lifting the latch that keeps the FPC in place, and removing three 1.3mm hex screws that secure the lens.

- The PCB is rather unspectacular but at the top, we can spot a significant contributor to GoPro's HyperSmooth stabilization, the Bosch BMI260 inertial measurement unit. "Are we there yet?" Not quite. There are two more Phillips #000 screws before we get a glimpse of the Mini's secondary PCB.

- On the top side, there is a GoPro's shutter button, a 0.5in 72x32px OLED display, and a Seiko ML414H backup battery. The bottom side is no less exciting. We find a Qualcomm QCA9377 WiFi and Bluetooth chipset and a top-facing MEMS microphone.

- Four T4 Torx screws hold the aluminum bracket in place. Lifting the metal frame out of the case reveals a power/pairing button and, on the bottom side, a front-facing MEMS microphone.

- Repairability Score: 2/10 (10 is easiest to repair). The lens cover can be twisted off and replaced. But the elephant in the room is the non-removable battery. Once open, components are easy to replace but opening it non-destructively is near-impossible.

Block all adverts in Windows

YOU'LL NEED THIS

A PC RUNNING WINDOWS 10 OR 11
Copy style of what's needed.

OVER THE LAST FEW YEARS, Microsoft has been peppering its operating system with nags, nudges, recommendations, and offers. You might say that's only to be expected, given that these days, most people haven't had to pay to get a new version of Windows, they simply upgraded for free. Perhaps that's why Microsoft is increasingly trying other ways to recoup its costs, including splashing adverts across its operating systems (both Windows 10 and 11). They're popping up in the Start menu, Cortana, Action Center, the lock screen, and more.

Most of the adverts originate from Microsoft itself and tend to be offers for its paid-for subscriptions and suggestions to perform tasks within Windows, rather than promotions from third parties, but they're annoying all the same. Thankfully though, there are ways of stopping your eyeballs from being bombarded by these offers—and it only takes a few tweaks in settings until we can go ad-free. Here, we will explain how to block them. **–NIK RAWLINSON**

1 BLOCK ADS IN THE START MENU AND LOCK SCREEN

Let's start by disabling adverts in the Windows 10 Start menu. Press Windows + I to open Settings, then click Personalization, followed by Start on the left [**Image A**].

» Click the slider below 'Show suggestions occasionally in Start' so that it slides to the left and turns from blue (on) to grey (off) [**Image A**].

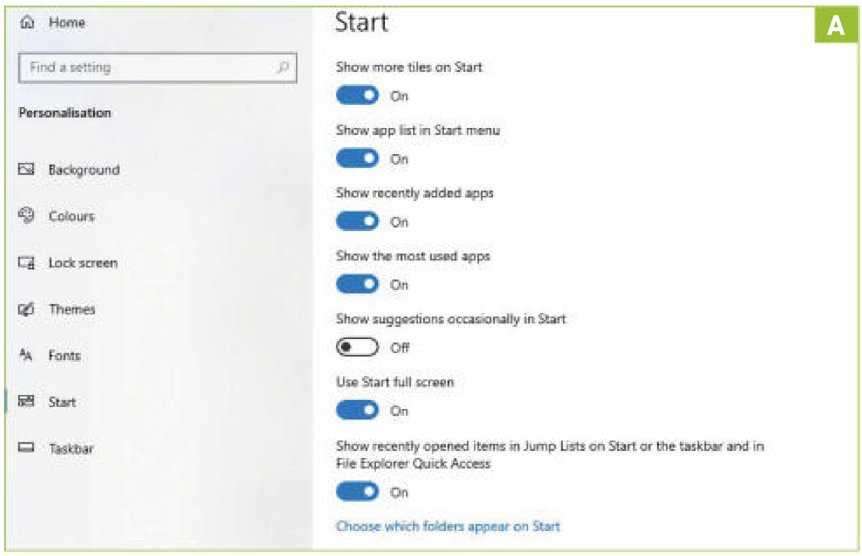
» While in the Personalization section, also click 'Lock screen' on the left [**Image B**], then select either Picture or Slideshow in the Background dropdown menu and turn off the slider below 'Get fun facts, tips and more from Windows and Cortana on your lock screen'.

» In Windows 11, you'll find a similar option to disable 'Get fun facts, tips and more on your lock screen' in the same settings location. This doesn't mention Cortana because it's not a default feature in that operating system. You'll find a box you need to untick rather than a slider to turn off.

2 TURN OFF ADS IN THE ACTION CENTRE

Adverts are also popping up as notifications in the Action Centre, which is the panel that appears when you click the speech bubble to the right of your taskbar in Windows 10, or the clock in Windows 11.

» To disable these notifications in Windows 10, return to the main Settings page, then click System followed by 'Notifications & actions' on the left. Here, untick 'Get tips, tricks, and suggestions as you use Windows'. If you're using Windows 11, in Settings click Notifications in the main section of the window. Scroll down and click 'Additional settings', then untick the box next to 'Get tips and suggestions when using Windows' [**Image C**].



Start

Show more tiles on Start
On

Show app list in Start menu
On

Show recently added apps
On

Show the most used apps
On

Show suggestions occasionally in Start
Off

Use Start full screen
On

Show recently opened items in Jump Lists on Start or the taskbar and in File Explorer Quick Access
On

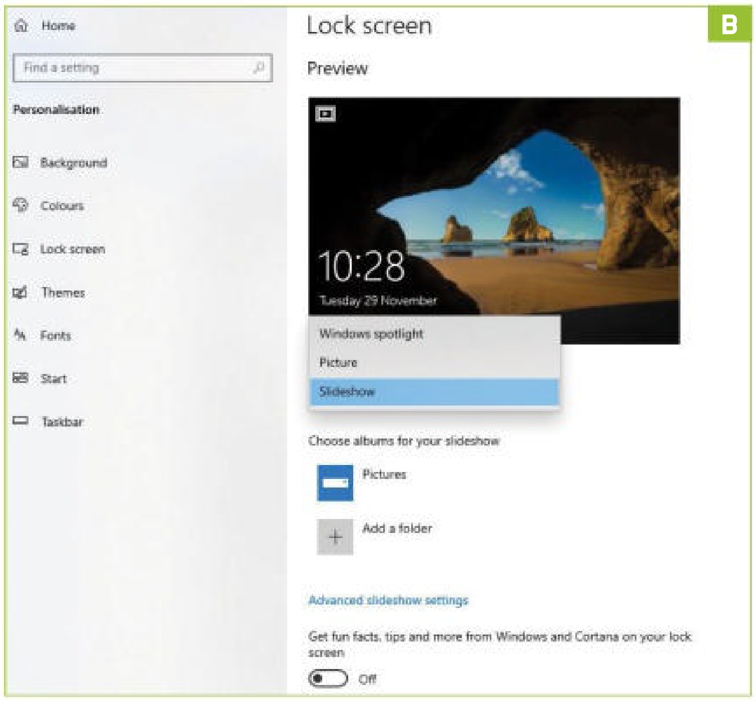
Choose which folders appear on Start

» **Disable suggestions in the Windows 10 Start menu by turning off the 'Show suggestions' setting.**

» The other two options in this section (in both Windows 10 and 11) are intended to help explain what's changed whenever your PC has been updated and to provide tips on how to get the most out of this updated version. Respectively, the options are 'Show me the Windows welcome experience after updates…', and 'Suggest ways to get more out of Windows…'. If you don't think you need this kind of help, unticking them stops these messages from Microsoft.

3 REMOVE ADS FROM THE START MENU

Sometimes, what seems to be an advert is actually a program that was installed as part of a Windows update. For example, in some countries, Microsoft recently installed apps for Disney+ and Spotify, even if



Lock screen

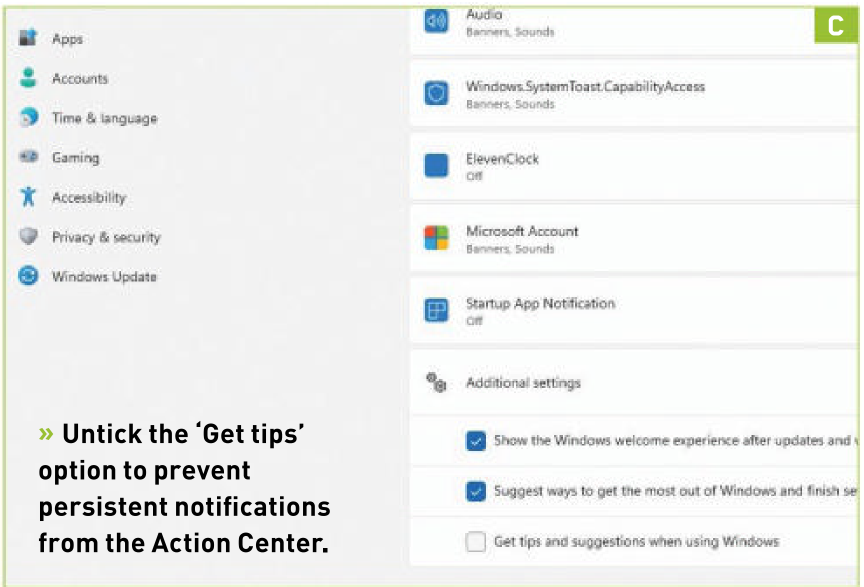
Preview

Choose albums for your slideshow

Get fun facts, tips and more from Windows and Cortana on your lock screen
Off

» **Turn off the 'Get fun facts' option to keep your lock screen free of Microsoft's clutter.**

© MICROSOFT


C
Apps
Accounts
Time & language
Gaming
Accessibility
Privacy & security
Windows Update
Additional settings

Audio
Banners, Sounds

Windows.SystemToast.CapabilityAccess
Banners, Sounds

ElevenClock
Off

Microsoft Account
Banners, Sounds

Startup App Notification
Off

☑ Show the Windows welcome experience after updates and

☑ Suggest ways to get the most out of Windows and finish se

☐ Get tips and suggestions when using Windows

» **Untick the 'Get tips' option to prevent persistent notifications from the Action Center.**

you'd never used them. These appeared as live tiles in Windows 10 [**Image D**], and on the Start menu in Windows 10 and 11.

» To remove a Windows 10 live tile from the Start menu and reclaim the space used by a program you need quick access to, right-click the tile and hover over More, then click 'Turn Live Tile off' [**Image D**]. If you don't want to use the associated program and would prefer to remove it, click Uninstall instead [**Image D**].

» To uninstall a program from Windows 11, or a Windows 10 program that doesn't appear as a live tile, right-click its entry on the Start menu, then click Uninstall.

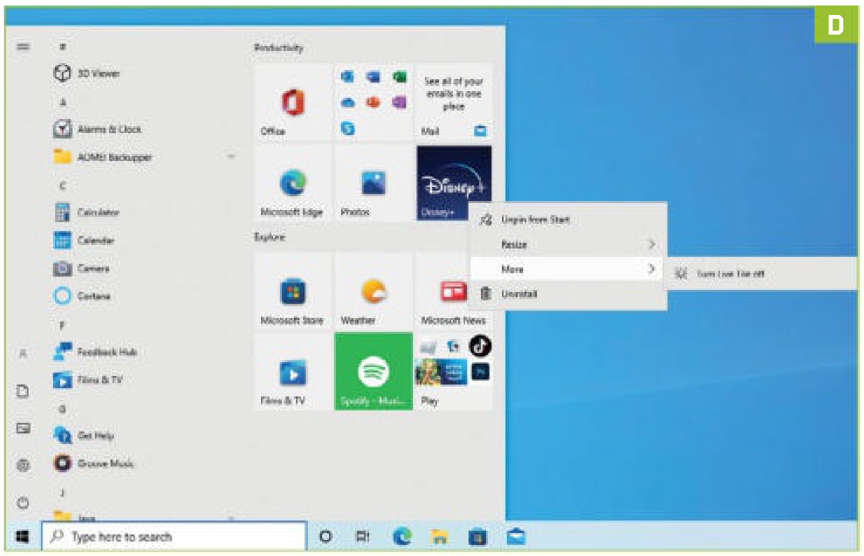
4 STOP MICROSOFT TRACKING YOU

Some of Microsoft's adverts you just can't block, however, you can stop the company from tracking you so that the ads aren't personalized to your interests.

» Log into your Microsoft account (https://account.microsoft.com), then click Privacy on the blue bar at the top of the screen. Scroll down to 'More privacy settings' at the bottom of the page, click 'Review ad settings', then switch off the slider below 'See ads that interest you' [**Image E**].

» Back in Windows, you can opt out of tracking when browsing with Microsoft's Edge browser. Click the three dots to the right of the address bar, then click Settings. Click 'Privacy, search, and services' in the sidebar, and make sure the slider next to 'Tracking prevention' is switched on (to the right).

» Based on the descriptions displayed, choose between Basic, Balanced or Strict tracking prevention by clicking one of the boxes below. Some websites may not work as expected if you enable the Strict option so switch back to Basic or Balanced if you encounter any problems.


D
Productivity
3D Viewer
Alarms & Clock
AOMEI Backupper
Calculator
Calendar
Camera
Cortana
Feedback Hub
Films & TV
Get Help
Groove Music
Office
Mail
See all of your emails in one place
Microsoft Edge
Photos
Disney+
Explore
Microsoft Store
Weather
Microsoft News
Films & TV
Spotify - Musi...
Play
Unpin from Start
Resize
More
Uninstall
Turn Live Tile off
Type here to search

» **Turn off live tiles in Windows 10 to block any more adverts for apps like Spotify, Disney Plus, and any other Microsoft clutter.**

BLOCK ADS IN 'SPLASH SCREENS'

Even if you block adverts in Windows itself, you'll still see advertising online and some of this may creep into programs that pull in promotions to display on splash screens that appear when they first launch. These have nothing to do with Microsoft or Windows and are more difficult to block since the process varies for each developer.

However, you can usually stop splash screens from showing at all, which is an alternative (and effective) way of tackling the problem. Look for an option to 'Show at launch' at the bottom of the screen and, if it's ticked, untick it. If there is no option, open the program's Settings or Tools menu, and look for a similar setting.

5 DISABLE ADS IN OUTLOOK

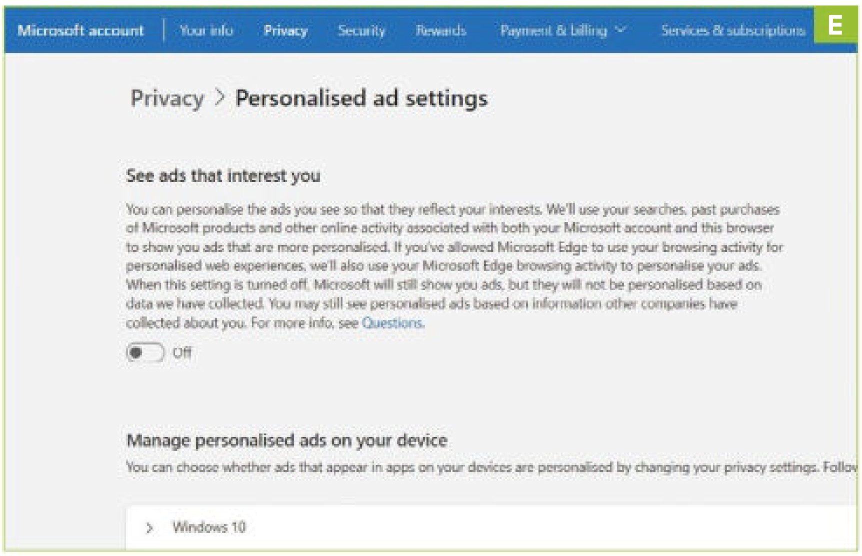
Unless you have a Microsoft 365 subscription, adverts will now also appear in Outlook.com's interface. A subscription for home use costs $70 a year for a single user and $100 a year for a family membership, which can be used by up to six people.

» If you'd like to take up either option, you can sign up for a subscription at (www.microsoft.com/microsoft-365).

» You may also have noticed ads appearing as what look like ordinary messages in the Outlook app for Android or iOS. Microsoft confirms on its support pages that Outlook Mobile is an "ad-supported product for free users" (tinyurl.com/y8spf7x9). The company also points out that these adverts are indicated by the word 'Ad' inside a blue box.

» The app lets you organize your emails into a single inbox containing every message, or you can split it into two inboxes: 'Focused' for important emails and 'Other' for the rest. It distinguishes these based on which emails you open and reply to. Emails from loved ones will appear in Focused, for example, while newsletters you rarely bother with get elbowed into Other.

» Previously, Microsoft only put ads in the Other inbox for free users but has recently started placing them in the single inbox as well. One way to see ads less frequently is to tap Focused above your messages. This moves them automatically to the Other inbox. ⏻


E
Microsoft account
Your info
Privacy
Security
Rewards
Payment & billing
Services & subscriptions

Privacy > Personalised ad settings

See ads that interest you

You can personalise the ads you see so that they reflect your interests. We'll use your searches, past purchases of Microsoft products and other online activity associated with both your Microsoft account and this browser to show you ads that are more personalised. If you've allowed Microsoft Edge to use your browsing activity for personalised web experiences, we'll also use your Microsoft Edge browsing activity to personalise your ads. When this setting is turned off, Microsoft will still show you ads, but they will not be personalised based on data we have collected. You may still see personalised ads based on information other companies have collected about you. For more info, see Questions.

○ Off

Manage personalised ads on your device

You can choose whether ads that appear in apps on your devices are personalised by changing your privacy settings. Follo

> Windows 10

» **Turn off this setting in the Privacy section to stop Microsoft showing you adverts based on your interests.**

Run Linux in a virtual machine

YOU'LL NEED THIS

VIRTUALBOX AND UBUNTU

Time required: Two hours.

THERE ARE PLENTY of reasons you should want to try out Linux, but in keeping with our first tutorial this month (see page 64), one of them is to make it harder for your activity to be tracked online. If you want to make sure you can't be tracked, our best advice would be to use a different PC. You can do this even if you don't have a second computer by setting up a virtual machine on your computer, which behaves as though it's an entirely separate device. If set up properly, nothing that happens on your virtual machine will impact your main Windows installation, meaning that any websites you visit won't be able to identify you.

Here, we're going to set up a virtual machine running Ubuntu, which is the version of Linux that Windows users will find most familiar. You can also do this with Windows, but that would require you to pay for a second license for the operating system.

The advantage of using Linux is that you can install it for free and, if you want to boost your security further, you can delete the virtual machine every few months and set up a new one at no cost. You don't need to use your Linux virtual machine every day—just start it up when you want to browse a site you're not so sure about, and shut it down again when you've finished. If you enjoy using Linux, you could even install it on an older PC—running Windows 7, say—to extend its working life. –**NIK RAWLINSON**

1 SET UP VIRTUALBOX

Visit VirtualBox (www.virtualbox.org) and click Downloads followed by 'Windows hosts' to download the most recent version of VirtualBox. Once done, navigate to your Downloads folder in File Explorer and double-click the executable file.

» A Windows User Account Control window will pop up asking if you're happy to run the software—click Yes, then click through the installation instructions, leaving all the options in their default states. When you reach the final screen, the option to start VirtualBox will be ticked. Leave it ticked and click Finish.

2 INSTALL LINUX

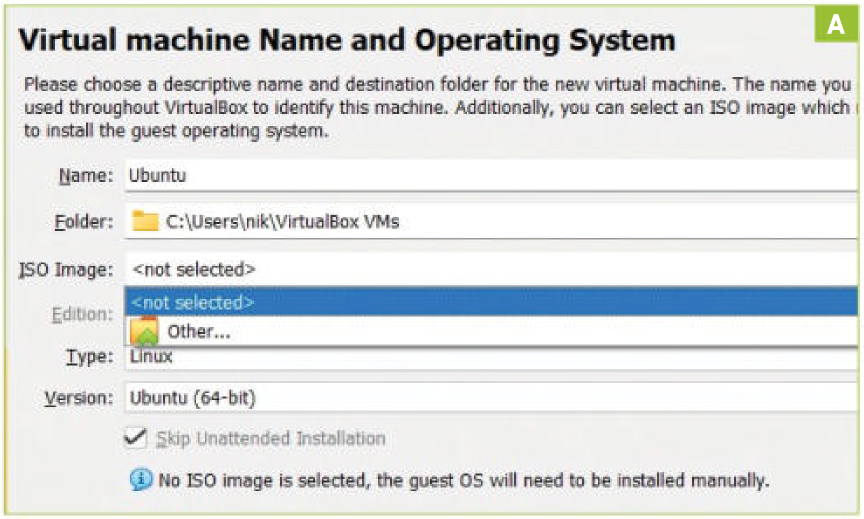
You now need to install a version of Linux to run within VirtualBox. As mentioned earlier, we'd recommend Ubuntu because it works in a similar way to Windows. Go to (ubuntu.com/download/desktop) and click the green download button to the right of Ubuntu 22.04.1 LTS.

» While this isn't the latest version—that is Ubuntu 22.10—the LTS at the end of its name stands for Long Term Support, which means it will be supported until April 2027 at least. Ubuntu 22.10, on the other hand, will be supported only until July 2023 (see wiki.ubuntu.com/Releases for all end-of-support dates). If you only intend to run the operating system occasionally, using a version with an extended support period means you won't have to carry out as many major upgrades relative to the number of times you use it.

» The installer is a fairly large file (3.6GB) and took just over 15 minutes to download to our computer. Once you've downloaded it, return to VirtualBox and press Ctrl+N to set up a new virtual machine. Type Ubuntu into the Name box, and make sure Linux is selected in the dropdown menu next to Type and that 'Ubuntu (64-bit) is selected beside Version. On our system, these were both selected by default, but if yours shows anything different, click the menus and correct them.

» Now click the down-pointing arrow at the end of the line beside ISO Image and click 'Other...' [**Image A**]. Select the Ubuntu installer you've just downloaded. Our download was named 'ubuntu-22.04.1-desktop-amd64.iso', but if there has been an update since we went to press, your filename may differ slightly. Click Open.

» VirtualBox can perform what's known as an unattended installation, where it will take care of most of the configuration for you. This saves you time, but we want to manually set up our user account in the Ubuntu graphical installer so it has the necessary rights to



Virtual machine Name and Operating System

Please choose a descriptive name and destination folder for the new virtual machine. The name you used throughout VirtualBox to identify this machine. Additionally, you can select an ISO image which to install the guest operating system.

Name: Ubuntu

Folder: C:\Users\nik\VirtualBox VMs

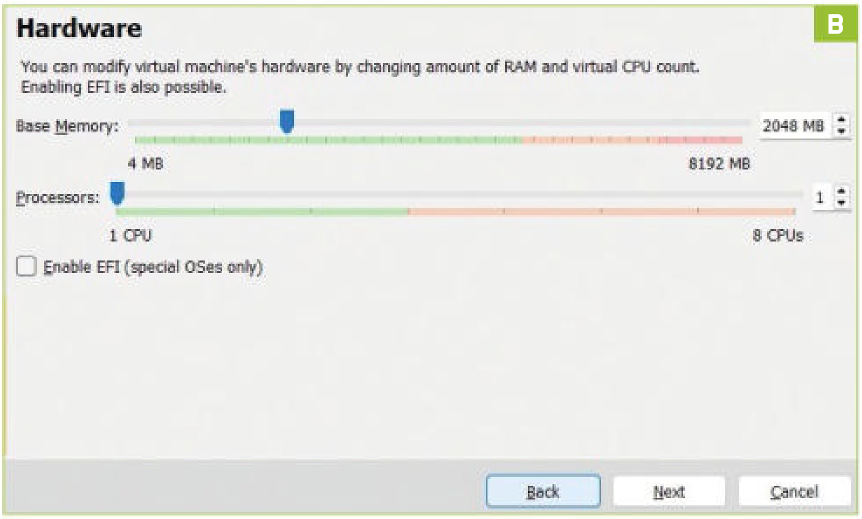
ISO Image: <not selected>

Type: Linux

Version: Ubuntu (64-bit)

☑ Skip Unattended Installation

No ISO image is selected, the guest OS will need to be installed manually.



Hardware

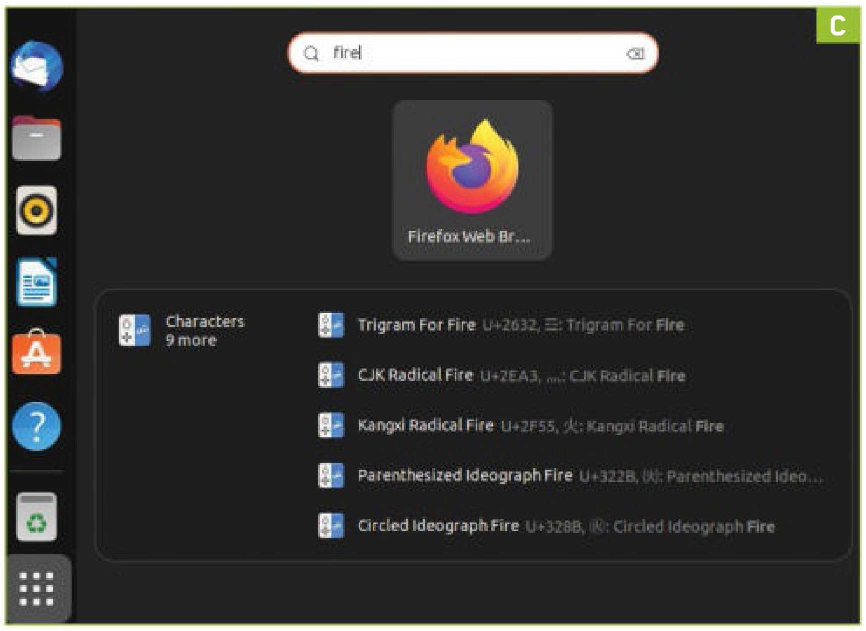
You can modify virtual machine's hardware by changing amount of RAM and virtual CPU count. Enabling EFI is also possible.

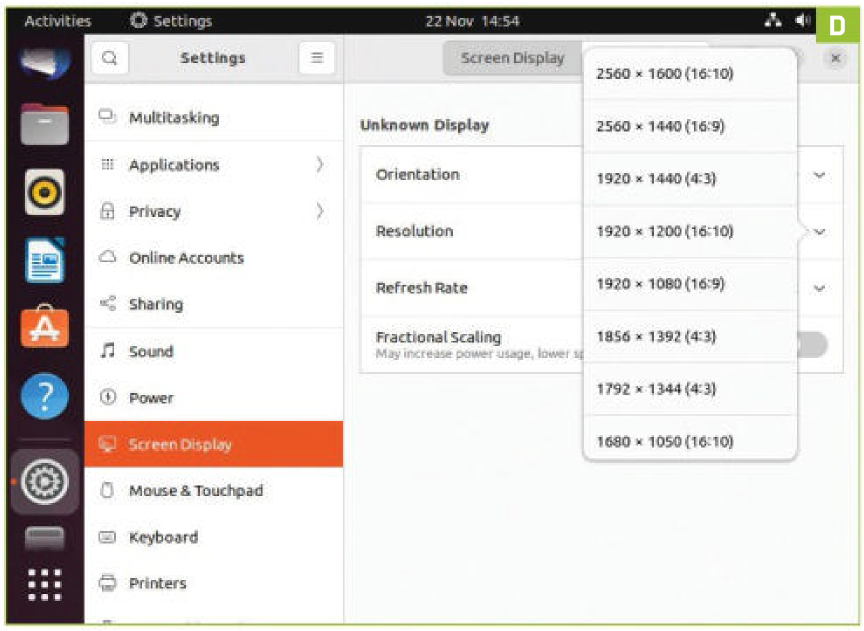
Base Memory: 2048 MB

Processors: 1

☐ Enable EFI (special OSes only)

© WWW.VIRTUALBOX.ORG


C
fire
Firefox Web Br...
Characters
9 more
Trigram For Fire U+2632, ☲: Trigram For Fire
CJK Radical Fire U+2EA3, ⺣: CJK Radical Fire
Kangxi Radical Fire U+2F55, ⽕: Kangxi Radical Fire
Parenthesized Ideograph Fire U+322B, ㈫: Parenthesized Ideo...
Circled Ideograph Fire U+328B, ㊋: Circled Ideograph Fire


D
Activities
Settings
22 Nov 14:54
Settings
Screen Display
Multitasking
Applications
Privacy
Online Accounts
Sharing
Sound
Power
Screen Display
Mouse & Touchpad
Keyboard
Printers
Unknown Display
Orientation
Resolution
Refresh Rate
Fractional Scaling
May increase power usage, lower sp
2560 × 1600 (16:10)
2560 × 1440 (16:9)
1920 × 1440 (4:3)
1920 × 1200 (16:10)
1920 × 1080 (16:9)
1856 × 1392 (4:3)
1792 × 1344 (4:3)
1680 × 1050 (16:10)

install software and perform other management tasks, without us having to configure it in Command Prompt once installation has finished. Therefore, tick the box next to Skip Unattended Installation [**Image A**] then click Next.

» You now need to decide how much of your computer's resources, such as processor cores and memory, Ubuntu should be allowed to use when it's running. Whatever you give it access to will be temporarily unavailable to Windows, so unless you're going to use Ubuntu on a regular basis there's no point giving it too many resources.

» VirtualBox will make a suggestion which, in our case, was one processor core and 2GB of memory [**Image B**], leaving three cores and 6GB of memory free for our main Windows installation. Once you've made your selection, click Next.

» Now, you need to allocate some of your hard-drive space to Linux. Again, if you're not going to use it often, there's no need to assign too much. VirtualBox recommends 25GB, which is Ubuntu's minimum system requirement. Drag the slider if you need to increase this, then click 'Next', followed by 'Finish'.

» Click 'Start' and VirtualBox will boot into the Ubuntu installer. When doing so, it displays a message containing four options. Leave 'Try or Install Ubuntu' selected and press Enter. It may take the interface several seconds to appear. When it does, select English in the sidebar, then click Install Ubuntu.

» On the following screen, click 'English (US)' in the panel below 'Choose your keyboard layout', then click Continue twice. On the next screen, leave 'Erase disk and install Ubuntu' selected, and click 'Install Now' at the bottom right. This action isn't as drastic as it sounds. The 'disk' referred to here is the file that will contain your virtual machine, not the hard drive in your computer that contains Windows.

» Click 'Continue', then select your time zone by clicking on the map. Now click Continue again, then enter your name, a name for your computer, a username, and a password.

» You'll only use the username and password for logging into Ubuntu, so make sure they're different from the ones you use for Windows. Click 'Continue' again and Ubuntu will start writing the necessary programs to the virtual disk you created inside VirtualBox.

» When the installation completes, you'll be prompted to restart the virtual machine. Click 'Restart Now' and, when Ubuntu has finished rebooting (Windows won't restart), log in with the username and password you created during the setup process.

» Follow the instructions on the screen, then click the Show Applications button at the bottom of the sidebar dock. Type 'fire' [**Image C**], then click on the Firefox icon to launch the browser.

3 FIX YOUR RESOLUTION

If the resolution of your virtual machine is too low and you're not able to fit much in the VirtualBox window, click Show Applications, type 'set', and click Settings.

» Next, click Screen Display on the left [**Image D**] and increase the number of pixels on your virtual display by clicking Resolution and selecting a higher setting.

WHAT IS A VIRTUAL MACHINE?

A virtual machine is a software-based computer that runs inside a piece of management software that borrows resources from the computer hosting it. In our example, the host computer is our main computer, and the management software is VirtualBox.

VirtualBox takes control of some of the host computer's memory and processor power and lends it to the virtual machine. The virtual machine will use these resources to run an operating system—in this case, Ubuntu and all the software installed within it. The virtual machine only exists as software on your hard drive, which means that as soon as you close it down, all the resources that it borrowed from your host machine will be released for use by the host again.

Because the virtual machine is contained within a single file, you can delete that file when you no longer need the virtual machine. If you start to notice that websites are tracking you on your virtual machine in exactly the same way they do on your physical computer, you can delete the virtual machine entirely, set up a new one, and start again.

To make this easier to understand, think of the management software as a program like Word, and the file containing the virtual machine as being a word-processed document. If you deleted the document, Word could still be used to create and edit other documents. In this example, Windows, which is hosting Word, would be entirely unaffected.

Stop your printer being hacked

YOU'LL NEED THIS

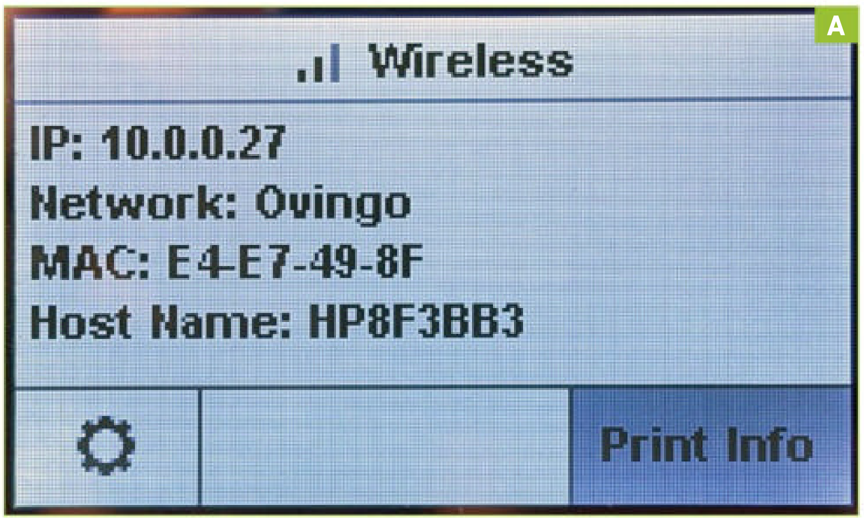
WEB-CONNECTED PRINTER

Time required: 30 minutes

ANY DEVICE THAT CAN connect to the internet needs to be kept secure. This is as true for printers as it is for laptops, phones, and tablets. Printers are increasingly becoming fully-featured online devices that download their own updates automatically, report how much ink you're using, and if you have signed up for a subscription or membership scheme, order new cartridges just before your current ones run out.

All of this makes life easier for you, but it also means you must add your printer to the list of devices you need to consider when assessing the security of your network. Fortunately, big-name printer manufacturers have a vested interest in keeping them safe. They don't want to risk the reputational damage of being associated with a widespread security breach and they wouldn't want to risk losing customers and the ink sales that go with them.

For the most part, then, as long as your printer is properly set up, it's probably safe. But that doesn't mean you should sit back and hand over responsibility for your network's protection to its manufacturer. Here, we'll guide you through the process of checking that your printer isn't a security risk, and explain how to keep it that way. **–NIK RAWLINSON**



Wireless

IP: 10.0.0.27

Network: Ovingo

MAC: E4-E7-49-8F

Host Name: HP8F3BB3

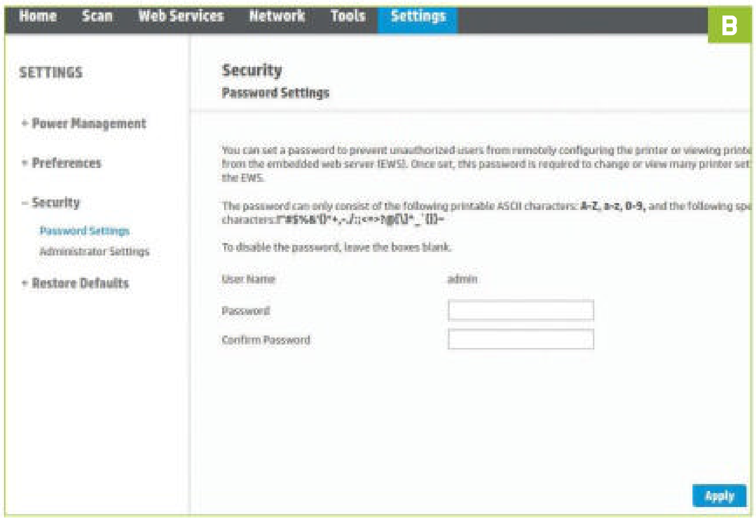
1 FIND YOUR PRINTER'S CONTROL PANEL

While you can typically perform basic configuration tasks using a printer's screen, connected devices usually have a far more advanced and flexible online dashboard that you access through a browser. There are two ways to find it—one is to check the machine's IP address using any onboard screen and buttons. We're using an HP Envy 5030 Wi-Fi-connected printer as our example. The precise instructions you need to follow will depend on your model, but the principles will be the same.

» Wake the screen and, on the Envy 5030, tap the wireless icon, which is the third image on the bottom bar. On the next screen, take note of the four sets of digits beside IP, which in our case is 10.0.0.27 [**Image A**]. If you don't have an equivalent icon on your printer, open its settings screens and look for options relating to network, connection, or Wi-Fi.

» You can also look up your printer's IP address through your router. Open the Windows menu and type CMD, then click Command Prompt. At the prompt, type 'ipconfig' and press Enter, then look for the four sets of digits beside Default Gateway. This is the address of your router on your network.

» In our case, it's 10.0.0.1, but 192.168.1.1 and 192.168.1.254 are common alternatives. Type the address into your browser and, if prompted for a password, check the back of the router, where the administrator login details should be on a sticker. These are different from the password you use to connect devices to Wi-Fi.



Security

Password Settings

You can set a password to prevent unauthorized users from remotely configuring the printer or viewing printe
from the embedded web server (EWS). Once set, this password is required to change or view many printer set
the EWS.

The password can only consist of the following printable ASCII characters: **A-Z, a-z, 0-9,** and the following spe
characters: !"#$%&'()*+,-./:;<=>?@[\]^_`{|}~

To disable the password, leave the boxes blank.

User Name admin

Password

Confirm Password

» Click through the router configuration pages until you find a list of devices on your network. On our Netgear Nighthawk AX8 router, for example, we get to the list by clicking Attached Devices. Now search for your printer.

» Our Netgear router helpfully has icons beside each device, which make it easy to distinguish between printers, smart speakers, satellite units in mesh Wi-Fi systems, and so on. We can therefore confirm that our printer is indeed located at 10.0.0.27. Type the printer's address into a browser to access its control panel.

2 ADD A PASSWORD TO YOUR ONLINE DASHBOARD

At this point, we encounter our first potential vulnerability, but we only have ourselves to blame. Typing the IP address gives us direct access to the dashboard without having to enter a password. In theory, that shouldn't be a problem as the firewall on our router should stop anyone from the outside world from getting as far as our printer. However, if there was a problem with the router, like a vulnerability or a missed update that exposed our network to hackers, our printer could be targeted.

» The first job, then, is to click Settings on the top bar, followed by Security, then Password Settings, in the sidebar. Type a complex password into the Password

© HP

box, repeat it in the Confirm Password box, then click Apply [**Image B**]. The standard advice about not recycling a password you've used elsewhere applies here—as does using a mix of upper- and lower-case letters, numbers and punctuation, and not using single regular words. Don't worry about forgetting the password: you can always write it on a label and stick it to the back of the printer where nobody will be able to find it unless they have physical access to the device.

3 CHECK YOUR PRINTER IS FULLY UPDATED

Printers run their own operating systems, which just like Windows, need to be updated regularly. Internet printers will do this automatically if they can connect to the manufacturer's servers, but it's worth checking, periodically, that there's no problem.

» On our Envy printer, we clicked Tools on the top bar, followed by Printer Updates in the sidebar, then Firmware Updates. Then we clicked the Check Now button 2 and the printer looked for the latest firmware release. Follow similar instructions on your printer and it will tell you if any firmware updates are available.

» Don't panic if your printer shows a connection error message, as ours did when we first visited the screen showing updates. This was caused by our broadband being temporarily offline, rather than a problem with the printer itself.

4 TURN OFF SERVICES YOU DON'T USE

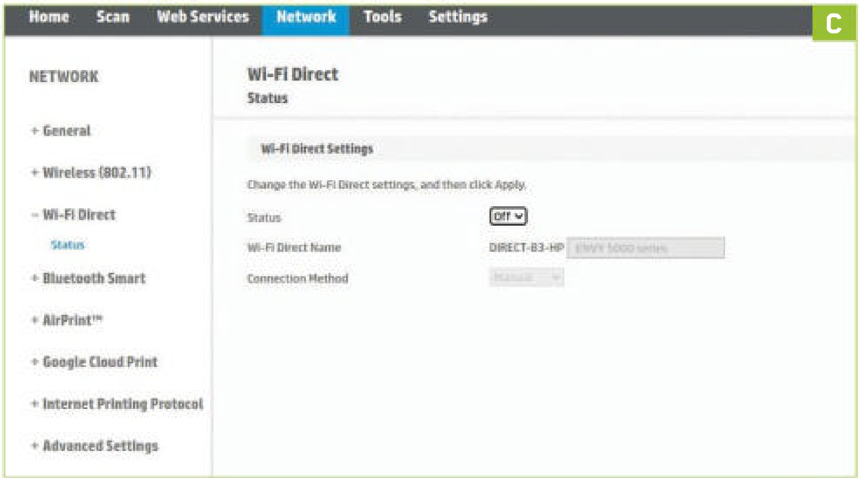
One of the best things about connected printers is that they let you use remote printing services, such as Google Cloud Print and HP ePrint. Cloud Print was a service that let you send documents to supported printers from anywhere on the internet, while HP ePrint lets you email documents for printing on any HP printer.

» Although Google Cloud Print is enabled on our device, Google no longer supports the service, so we might as well switch it off. We did this on our Envy printer by clicking 'Settings' on the top bar, followed by Security in the sidebar, then Administrator Settings. We then unticked the box beside Google Cloud Print, which disabled the option to 'Print with Google Cloud Print over Wireless Network'. Finally, we clicked Apply.

» If you're using a connected HP printer and never use its ePrint service for emailing documents to the device, you can disable ePrint by clicking Web Services, followed by Summary, then clicking the Turn Off button beside HP ePrint.

» You might also consider turning off Wi-Fi Direct, which lets supported devices access the printer without going through the wireless network. We did this by clicking Network on the top bar, followed by Wi-Fi Direct in the sidebar, then Status [**Image C**]. Then we clicked Edit Settings and selected Off in the dropdown menu beside Status. As before, clicking Apply completes the job.

» Whichever brand of printer you're using, don't disable any services related to your ink-subscription service, if you have one.

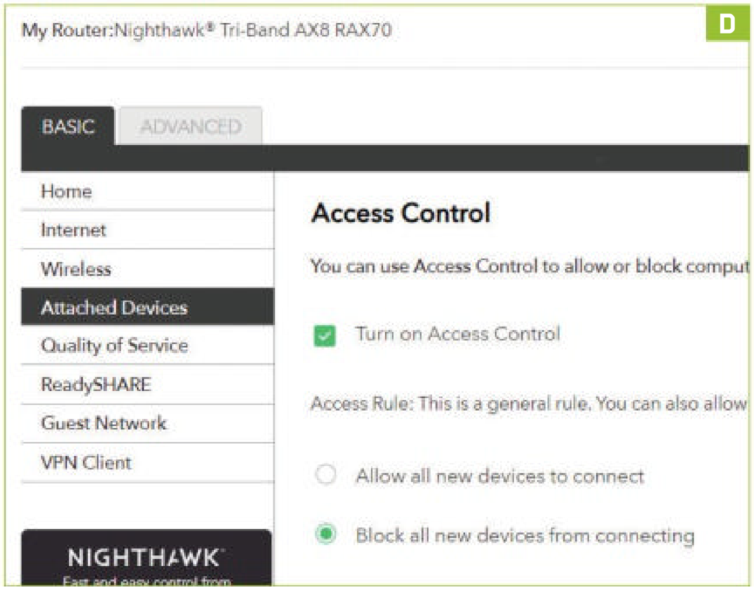


Wi-Fi Direct
Status

Wi-Fi Direct Settings

Change the Wi-Fi Direct settings, and then click Apply.

Status: Off
Wi-Fi Direct Name: DIRECT-83-HP ENVY 5000 series
Connection Method: Manual



My Router:Nighthawk® Tri-Band AX8 RAX70

Access Control

You can use Access Control to allow or block comput

☑ Turn on Access Control

Access Rule: This is a general rule. You can also allow

○ Allow all new devices to connect
● Block all new devices from connecting

On the Envy 5030, for example, this is done by clicking Web Services, followed by Remove Web Services in the sidebar, then the Remove Web Services button. Doing this may prevent the device from reporting usage and ink levels to the manufacturer, so replacement cartridges might not arrive when you need them.

5 CHANGE YOUR NETWORK PASSWORD

When did you last change the password for your home network? We can understand why it might be a while (or never) as it's not something you want to do on a whim. When you do, you'll need to update the password on all your computers, smartphones, smart TVs, tablets, smart speakers—and printers.

» If it's been six months or more, though, it's a sensible move, as it limits the amount of time unauthorized users will have access to your network and each of the devices connected to it.

» Log into your router using the process outlined above, then click through the configuration pages until you find the security settings. On our Netgear router, we found them by clicking Wireless, then scrolling down to Security Options.

6 PREVENT NEW DEVICES FROM CONNECTING TO YOUR PRINTER

Now that you've updated your network and limited the number of ways devices can access your printer remotely, the only way anyone can use it should be via your wireless network—especially if you've disabled features such as Wi-Fi Direct. Preventing new devices from connecting to your network will therefore block any unexpected and unauthorized computers, tablets, or phones from accessing the printer via the router.

» Make sure all the devices you regularly use are switched on and online, including smart speakers, streaming TVs, and so on, even though they will never need to use the printer. Now use your browser to connect to your router's control pages and look for an option to enable Access Control or a similarly named feature.

» On our Netgear router, this is done by clicking Attached Devices, followed by the Access Control link at the top of the page. Enable 'Access Control', then tick the 'Turn on Access Control' box [**Image D**]. Now click the button beside 'Block all new devices from connecting', followed by Apply. Any devices that aren't already connected to your wireless network will now be prevented from joining without your authorization.

Expand your laptop's keyboard

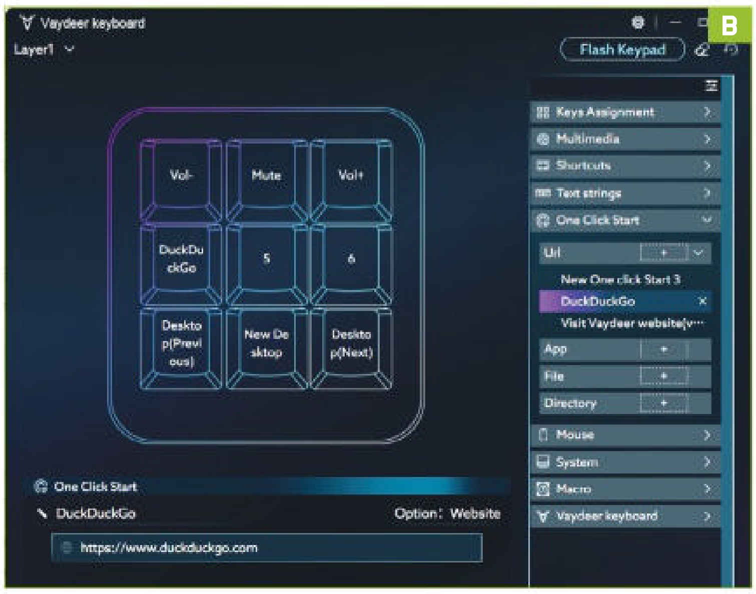
YOU'LL NEED THIS

A LAPTOP COMPUTER
A mobile phone (optional)

IF YOU WANT A COMPACT LAPTOP, you'll usually need to compromise by foregoing the numeric keypad on the right. The number keys at the top of the keyboard are a decent stand-in for occasional use, but for anything else, it's worth adding an external keypad dedicated to digits.

Thankfully, there are plenty of options, including programmable pads and phone apps. You can pick up a good numeric keypad, such as the Targus Numeric Keypad with USB Port Connector (tinyurl.com/54ud9ws7) for less than $25. This has a full complement of numeric and mathematical buttons, as well as Enter, Back, and Tab keys. If you're doing data entry or spreadsheet work, adding a device like this can be much quicker than using the horizontal number keys above your keyboard.

Microsoft has a more versatile solution in its Number Pad, also costing $25 (tinyurl.com/4bxyvru8). Available in black or white, you can pair it with up to three devices using Bluetooth, and switch between them. It's powered by a single battery, with a claimed working life of up to 24 months between battery changes. **–NIK RAWLINSON**



One Click Start
DuckDuckGo
Option: Website
https://www.duckduckgo.com

1 SET UP YOUR KEYPAD

Even if you can manage without a numeric keypad, you might still find a programmable keypad useful. These let you assign specific tasks to each button, which you can execute with a single press. We've tested the excellent Vaydeer One-Handed Macro Keyboard, costing $46 (tinyurl.com/yjtdj7t5) [**Image A**], which has nine buttons, each with a satisfying 'clicky' action thanks to the tactile key switches beneath them.

» By default, it's set up to behave like a regular external number pad—albeit one without a zero key—with the bottom-left button typing 1, the top right typing 9, and so on. However, the whole point of a keyboard like this is that you can reassign the function of each key using the accompanying software. Download this from (vaydeer.cn/download) by clicking the 'Vaydeer keyboard Setup 1.2.0-Windows.zip' link.

» Once it's done, launch the downloaded file and click 'Extract all' on the File Explorer toolbar. Extract the contents to your Downloads folder, then launch the 'Vaydeer keyboard setup' program. Plug in your keyboard and a visual representation will appear on the launch screen. Click to continue the setup process.

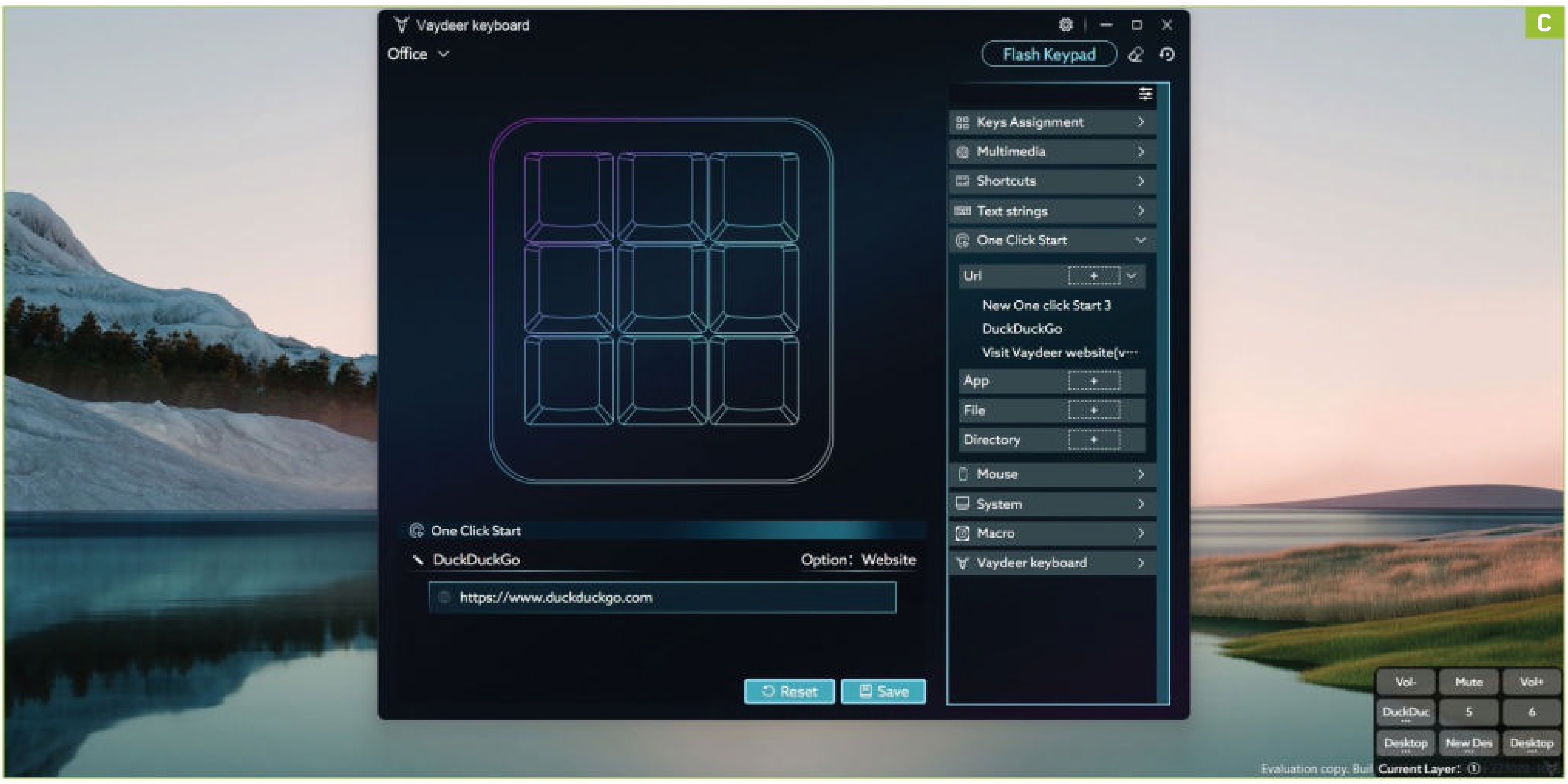
» Now work your way through the various categories of functions in the right-hand sidebar. As seen in [**Image B**], which shows our keypad halfway through configuration, we've chosen to put three volume controls on the top row, for volume down, mute, and up, respectively, from left to right, and three Desktop controls on the bottom row.

» Pressing the lower button creates a new desktop and the buttons to the left and right move backward and forward. We've also set the first button on the center row to open the privacy-focused DuckDuckGo search engine.

» If you want to do something similar, start by clicking the sidebar's Multimedia heading, then click and drag 'Vol-' onto the top-left button on the on-screen keypad. Drag 'Vol+' to the top-right button, and Mute to the top center. You'll find the Desktop controls, which you can set in the same way, by expanding the System section.

» To specify a website to open, expand the One Click Start section then click Url. Now click the 'New One click start' line below the image of the keypad, delete the text, and give it a meaningful description, like 'DuckDuckGo'. Next, click in the box below and type the address you want the button to launch, including the 'https://' prefix. The easiest way to do this is to visit the page in your browser, which will include the relevant prefix, then copy the address from the browser's address bar into the box in the keypad setup program. When you've done this, click Save, and drag the website from the sidebar onto the button to which you want to assign it.

© VAYDEER, LENOVO



One Click Start
DuckDuckGo Option: Website
https://www.duckduckgo.com

C

2 TRANSFER YOUR COMMANDS TO THE KEYPAD

So far, all you've done is tell the program what you want each button to do, but you haven't yet transferred the commands to the keypad itself, which will still type 1, 2, 3, and so on. Click 'Flash Keypad' at the top of the interface to transfer the commands to the keypad, then try them by pressing the keypad buttons. If you want to change any function at any time, simply drag a new one on top of an existing setting and click Flash Keypad again.

» We might only have nine buttons at our disposal, but you can still program up to 54 commands across six virtual 'layers'. You can program one layer of nine functions that you use in LibreOffice, nine for PaintShop Pro, nine for your browser, and so on. To switch between each of these virtual layers, hover your cursor over the Current Layer line at the bottom of the keypad head-up display (HUD) at the bottom right of your screen [**Image C**], and turn the mouse's scroll wheel or use two-finger scrolling on your trackpad.

» This HUD remains in view, even when you're not changing layers, and shows which function you've assigned to each button. It's useful when you're just getting used to the keypad, but when pressing the buttons becomes second nature (like touch-typing) you can hide the HUD and reclaim the screen space. Click the up-pointing icon on the Windows taskbar to reveal your hidden icons and right-click the Vaydeer icon. Click 'Close the HUD' on the menu that appears. To reveal it again, repeat this process, but this time select 'Open the HUD'.

3 USE A KEYPAD PHONE APP

You can also use your smartphone as an external numeric keypad, with on-screen buttons that, when tapped, send their output to your computer.

» Numeric Keyboard Lite for Android (tinyurl.com/2zphpvhv) comes with ads but you can remove them by buying the Pro version for less than a dollar. You'll also need to install the free server app from (www.numerickeyboard.com) and launch that and the Android app while your computer and phone are connected to the same wireless network.

» When your phone spots your computer, tap the computer's name on the phone's screen to pair them and display the keyboard. You can now use the on-screen buttons as though the phone was a physical keyboard.

» If you have an iPhone, 'Virtual KeyPad and NumPad' (tinyurl.com/5dj843rz) is free to download but you'll need to pay either $1 a month or a one-off $4 for lifetime access to get rid of the ads and add extra features.

» If you don't want to pay or you simply want to try before you buy, scroll down and tap Dismiss. Again, it relies on server software running on your PC to connect. This is a free download from (cherpake.com/get/#dl_section). Just click the Download button.

TRY A LAPTOP WITH A NUMERIC KEYPAD

If you're happy working with a larger laptop, you can buy one that has a numeric keypad. One of the most affordable options is Lenovo's ThinkPad E15 Gen 4, costing $738 (https://tinyurl.com/27ebfy3w), which we've used and would recommend. The keyboard is comfortable for typing, though the 15.6in screen is slightly dull.

LAB NOTES

GUY COCKER, EDITOR-IN-CHIEF

Tech Trends from CES

Beyond the products and into the future of the PC platform itself

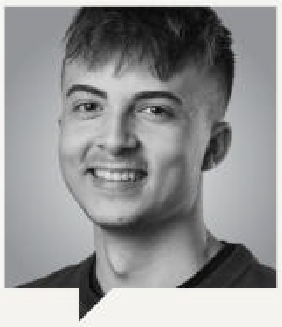
THIS MONTH, I was lucky enough to head out to Las Vegas for this year's Consumer Electronics Show. You can read my full report on page 32, where I pick out the best products. As I mentioned in my editor's intro, there were many more great products than I could cover in the 35 I was able to pick for inclusion in the ten-page feature.

But here, I want to talk about the general trends I spotted at the show and why I think this year was one of the best for PC fans. There was a mountain of RTX 4000-series powered laptops on show from the likes of Lenovo, Acer, and particularly, Asus. While, at the time of writing, prices are being kept under wraps (although $3,000-$4,000 seems likely for top-end 4090 models), the slimness of some of these models, in particular, the Asus ROG Zephyrus G14, means they combine portability, and power in a way we've not seen before. And seeing one RTX 4090 machine power a triple-screen racing rig made me want to ditch my desktop, cost be damned.

But even bigger than laptops at CES were displays. OLED panels, pretty much limited to my beloved Alienware AW3423DW today, are set to be in everything in 2023, from laptops to gaming displays and professional monitors like the Asus ProArt Display OLED. Samsung is also showing it will never stop when it comes to making the biggest and widest screens possible in its Odyssey range, while Alienware was pushing refresh rates to 500Hz on its eSports-focused AW2524H monitor.

There's one area I'd like to see the PC industry go faster though—recycling and upgradability. The rest of the show was awash with 'green' products, such as Samsung's microplastic-filtering washing machine and the Lightyear 2 solar-powered car. Dell's modular Concept Luna showed us a future where laptops can be taken apart and upgraded with a simple SIM card removal tool, but such a product being readily available still feels some way off.

Dell's Project Luna—a cool concept, but one we need to become a real product soon.



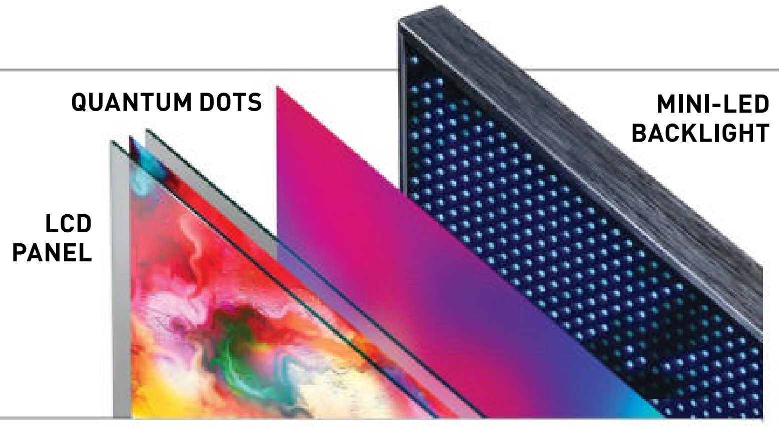
SAM LEWIS

Staff Writer

We're all aware of the short lifespan that modern technology has, especially with new variants of devices coming out on what seems like a monthly basis. Without wanting to sound older than my 23 years, I was digging through some stuff and found an iPad Mini 3rd generation. Initially, I was going to sell it, but I wondered if there was any way I could get some use out of it. I use an iPhone for the majority of my procrastination and, if I'm not using that, I'm usually at my desk or using my laptop, so I knew I wouldn't be using it much.

After some research, I found that you could use an iPad as a secondary display for your PC with spacedesk.net. What this does is stream your display to the iPad or iPhone wirelessly to give your desktop some more real estate. Bear in mind that the better your internet connection, the lower the latency—the same way as if you were remotely playing games. All I had to do was download the app on my iPad, then head to the spacedesk website, download the latest driver, head back to the app and select my PC from the available list and just like that, I have an extra display to play with. One of the ways I use the iPad is to have it vertically mounted to the right of my monitor to display the magazine's workflow while I'm working. So if you have an old tablet laying around collecting dust, see if this can give it a new lease of life.

© DELL



miniLED displays, like this one, could soon become common on all kinds of devices.

Editor's Pick: A.N. Other broken miniLED monitor

What's going on with monitor makers these days?

I'M NOT GOING to reveal the brand responsible for this particular train wreck for reasons that will become clear. But the model in question is a 34-inch ultra-wide with miniLED backlight, 165Hz refresh, and an eye-popping peak HDR luminance spec well into four figures in terms of nits.

Sure enough, it was a sizzler out of the box. At default settings, it was also clear the color saturation was out of whack, but I've learned not to panic at that sort of thing. Often there are alternative modes that get the screen running right without the need for calibration. Anyway, I flicked the switch in Windows to enable HDR and it was obvious something was up. At first, I thought it suffered from the same flickering problems that blight the Samsung Neo G9. But this wasn't the same kind of flickering.

Instead, it became apparent that the local dimming algorithm was doing some odd things in response to the image being displayed. When any significantly-sized and lighter-hued object appeared, whether in a video stream or web page, the whole panel would brighten and then darken again when it vanished. Watching a YouTube video in a browser window, the panel would brighten and dim in sympathy with the images in the video.

The only saving grace was that it didn't flicker with a static image, which isn't something you can say of that Samsung display. Speaking of which, were it not for my experience with broken monitors, I'd have found it hard to believe that this other big brand could deem this monitor fit for customers. But if Samsung can sell such an obviously flawed product, why not another major outfit?

As I dug deeper, I found further flaws with the local dimming algorithm. It turned out the excess color saturation was a global calibration problem present in every SDR and HDR mode, including SRGB mode, which can normally be relied on to be accurate. All this from a brand that usually delivers quality monitors.

I've yet to see a local dimming algorithm that I'd be happy with day-to-day. Obviously, this doesn't change that, or my conviction that any LCD panel with local dimming is inherently a kludge. There will always be trade-offs compared with true per-pixel lighting. Of course, issues with other PC component classes aren't unheard of—consider Nvidia's melty GPU power connectors or the problems AMD had with vapor chambers on its Radeon RX 7900 XTX boards. But those are isolated issues that only emerge in specific circumstances. Most of the time, the product works so, you can see how the problems were missed, even if proper quality control should have found them.

With these borked local-dimming screens, problems are visible all the time in HDR mode, and SDR mode when local dimming is enabled. I can't understand how multiple companies think this is acceptable. The one saving grace with this panel is that an email arrived just before we hit the 'publish' button, saying the manufacturer was aware of issues with the monitor and that the launch was on hold while the problems were addressed.

If the final retail version is sorted, it doesn't seem fair to name and shame the brand for now. But this screen was so bad on so many levels, I've got a feeling that when it re-emerges it will only be partially fixed. If they do manage to make it perfect, it will be the world's first miniLED monitor that isn't a bit broken. **–JL**

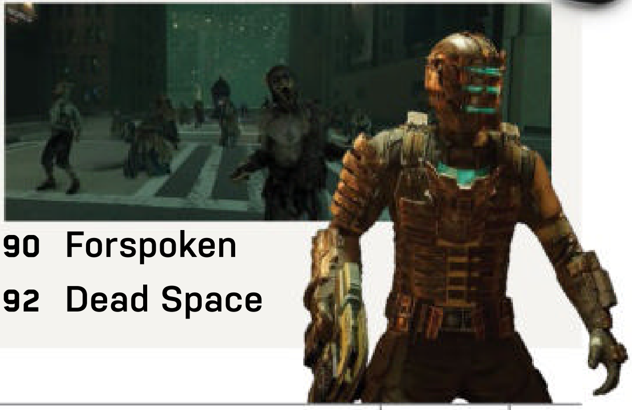
Reviewed...

74 Nvidia GeForce RTX 4070 Ti

76 Samsung Odyssey Neo G8

78 Lenovo Yoga Slim 9i
80 Linksys Atlas Pro 6 (AX5400)

82 Intel NUC 13 Extreme Raptor Canyon
84 Netgear Orbi RBK763
87 Corsair HS65 Surround Wireless
88 Roccat Kone Air Wireless
89 Roccat Vulcan II Max



90 Forspoken
92 Dead Space

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Nvidia GeForce RTX 4070 Ti

Let me introduce myself, again

AFTER 'UNLAUNCHING' the RTX 4080 12GB, the Ada Lovelace AD104 GPU returns in the form of the RTX 4070 Ti—with the exact same specs as before but also a $100 price cut. Perhaps Nvidia hoped the price reduction would garner some goodwill, but as the generational replacement for the RTX 3070 Ti, we're also looking at a $200 increase in price. And the 3070 Ti already felt overpriced.

The good news is that you get a lot more performance from the 4070 Ti than from the 3070 Ti. It's over 50 percent faster at 4K, and just under 50 percent faster at 1440p. It's also close to the same level of performance offered by the previous generation RTX 3090, even though it has half the VRAM and half the memory interface width. That bit is impressive and shows just how much the larger L2 cache

has helped performance with the Ada Lovelace architecture.

AMD accomplished the same feat with its Infinity Cache in RDNA 2, and that lives on in RDNA 3. But a 48MB L2 cache can only go so far, and relative performance drops off a bit more at 4K—the previous generation 3090 and 3080 Ti narrow the gap, thanks to their 384-bit interfaces.

Against AMD's latest RX 7900 XT, the 4070 Ti trailed by an average of 10 percent at 4K in rasterization games. Switching over to ray tracing games flips the tables, with the 4070 Ti leading by 24 percent on average. In other words, it's the same story we're used to from the previous generation, where AMD prioritizes rasterization and relegates DXR to secondary status.

Nvidia is also keen to point out the advantages of DLSS 2 and the new DLSS 3. The former boosted performance by 40 percent on average in rasterization games, using Quality mode (2x) upscaling; in DXR games, the same settings were good for 75 percent more performance on average. Meanwhile, DLSS 3's Frame Generation (FG), still using Quality mode upscaling, was good for another 40 percent boost at 4K in the games we tested, and a 60 percent improvement at 1440p. That's because CPU bottlenecks generally play a bigger role at lower resolutions, allowing the FG to provide a greater benefit.

But while we're on the subject of DLSS 3, let's be clear that these generated frames aren't quite the same as fully rendered frames. The latter incorporates updated user input, while FG basically adds an extra frame of latency into the rendering pipeline. FG is a great way to inflate benchmark scores, but the real-world benefits are far more nebulous. While Nvidia claims the 4070 Ti is 1.8x faster than the 3090 Ti in games with DLSS 3 support, we take exception to such comparisons.

DLSS 3 provides more like a 10 to 20 percent improvement in feel compared to the base framerate, not an 80 percent improvement. You're exchanging lower latency for higher FPS. It's an interesting technology, and we like having the option to enable it. But it's being used by Nvidia's marketing team to make the RTX 40-series look better than it is.

The RTX 4070 Ti ultimately delivers just 23 percent more performance across our expanded test suite, compared with the previous generation RTX 3080 10GB, and it has a 14 percent higher MSRP—with many cards, such as the Asus TUF Gaming OC, starting at $900. At least cryptocurrency mining isn't exacerbating things, but a net value proposition improvement is hardly revolutionary.

Sadly, most of the high-end RTX 30-series cards are now phased out, with prices on the rise, but this is a massive jump in 70 Ti-class GPU pricing. The 1070 Ti back in 2017 cost $449. We're now close to double that, some way over the 22 percent inflation we've experienced in the US over the same period. The 4070 Ti would be far more impressive and enticing at the same $599 price point of the 3070 Ti... except then scalpers would probably just ruin the party and jack the price back up to $800. **–JARRED WALTON**

VERDICT

6

Nvidia GeForce RTX 4070 Ti

+ **REWORK** Good performance; $100 price cut; DLSS 3.

– **REHASH** $200 price increase; 192-bit interface; DLSS 3.

$799, https://www.nvidia.com/

SPECIFICATIONS

Architecture	Ada AD104
Lithography	TSMC 4N
Boost clock	2730MHz
GPU shaders	7680
Memory	12GB GDDR6X
TFLOPS FP32	41.9
Bandwidth	504GB/s
TBP	285W
Connectors	2x HDMI 2.1, 3x DisplayPort 1.4a

BENCHMARKS

	RTX 4070 Ti	RTX 4080	RX 7900 XT	RTX 3070 Ti
10 Game Average (Geomean)	100 / 59	**116 / 74**	103 / 63	68 / 38
Borderlands 3	131 / 70	**166 / 89**	165 / **89**	87 / 44
Control (DXR)	71 / 34	**94 / 45**	63 / 30	48 / 25
Cyberpunk 2077 (DXR)	50 / 23	**63 / 30**	36/ 17	30 / 6
Far Cry 6	154 / 89	158 / **108**	**172** / 106	111 / 65
Flight Simulator	81 / 55	**82 / 76**	**82** / 63	65 / 36
Forza Horizon 5	141 / 105	**152 / 124**	131 / 98	97 / 62
Minecraft (DXR)	67 / 35	**81 / 44**	45 / 22	745 / 22
A Plague Tale: Requiem	82 / 44	**102 / 56**	89 / 50	52 / 30
Red Dead Redemption 2	105 / 66	**128 / 83**	111 / 74	70 / 46
Watch Dogs Legion	118 / 67	**138 / 86**	**138** / 83	79 / 41

Best scores are in bold. All testing conducted with a Core i9-13900K, MSI MEG Z790 Ace, G.Skill 2x16GB DDR5-6600 CL34, 4TB Sabrent Rocket 4 Plus-G, and be quiet! Dark Power Pro 12 1500W. Scores are average framerates at 2560x1440 / 3840x2160 ultra, with ray tracing enabled in Control, Cyberpunk, and Spider-Man.

Nvidia is skipping the reference Founders Edition for the 4070 Ti, so we have the triple-slot Asus TUF Gaming OC instead, with a modest 120MHz overclock.

Samsung Odyssey Neo G8

Can one screen do it all?

ON PAPER, the new Samsung Odyssey Neo G8 looks like one heck of a gaming monitor. This 4K beauty runs at up to a 240Hz refresh rate, packs a mini-LED backlight with 1,196 zones, can hit 2,000 nits of brightness, and achieves a 1ms response time. Numbers like that don't come cheap, but at $1,299, the Neo G8 isn't quite as pricey as you might expect.

On the flip side, potential buyers should bear in mind the relatively tight 1000R curve on the VA panel in this 32-inch 16:9 aspect screen. Curved gaming screens aren't for everyone, and they tend to work better on larger displays, such as the 55-inch Odyssey Ark (see review, Jan 2023 issue). You may also want to factor in the G8's lack of USB-C connectivity, which is a conspicuous omission.

The Neo G8 shares design features with the flagship Samsung Odyssey monitor, the Neo G9, including a mix of black and glossy white plastics and an RGB LED lighting ring on the rear. It looks premium, although the build quality doesn't feel all that robust. Give the screen a gentle push and it rocks back and forth more than you might expect.

For connectivity, there are DisplayPort and HDMI interfaces, with one of the former and two of the latter in HDMI 2.1 form. That allows for 240Hz operation over HDMI at the full 4K resolution of 3,840x2,160 pixels, which will please those with PS5 or Xbox Series consoles.

Samsung has opted for VA panel tech, including quantum dot enhancement for more vibrant colors, when the high-refresh 4K competition uses IPS tech. Typically, VA delivers better contrast and richer colors than IPS at the cost of speed, but Samsung has delivered VA monitors as fast as the best IPS screens. The other party trick involves a 1,196-zone mini-LED backlight, resulting in a peak brightness of 2,000 nits.

The Neo G8 does some things well. Pixel response is outstanding, as good as any IPS monitor, with only OLED screens, such as the Alienware AW3423DW, being quicker. The Neo G8 does not allow pixel overdrive and adaptive refresh at the same time, forcing you to choose between smoothness and speed. But even with overdrive off, the G8 is still quick.

The 240Hz refresh also delivers low latency, provided you have a graphics card fast enough to deliver high frame rates at 4K resolution. If so, the G8 can deliver ultra-low lag in that *CS:GO* session, epic detail for a *Total War* adventure, and stunning HDR visuals in *Cyberpunk 2077.*

In SDR mode on a Windows desktop, you can see the various zones adjusting to Samsung's algorithms, lighting up parts of the display and dimming others in an intrusive, clunky manner. Local dimming can be disabled in SDR mode but it's essential for HDR performance. It never comes close to the advertised 2,000 nits.

The Neo G8 is an incredibly well-rounded monitor. 240Hz and 4K is a potent combo and makes this one of the few monitors that can cope with hair-trigger online games and graphics-heavy titles alike. For gamers, only the fact that this isn't an OLED, with the incredible visuals offered by per-pixel lighting, will be enough to put them off. Despite that, the Neo G8 is a stellar gaming monitor if you want one screen to do it all—PC and console gaming, and some Windows and work stuff as well. **–JEREMY LAIRD**

VERDICT

9

Samsung Odyssey Neo G8

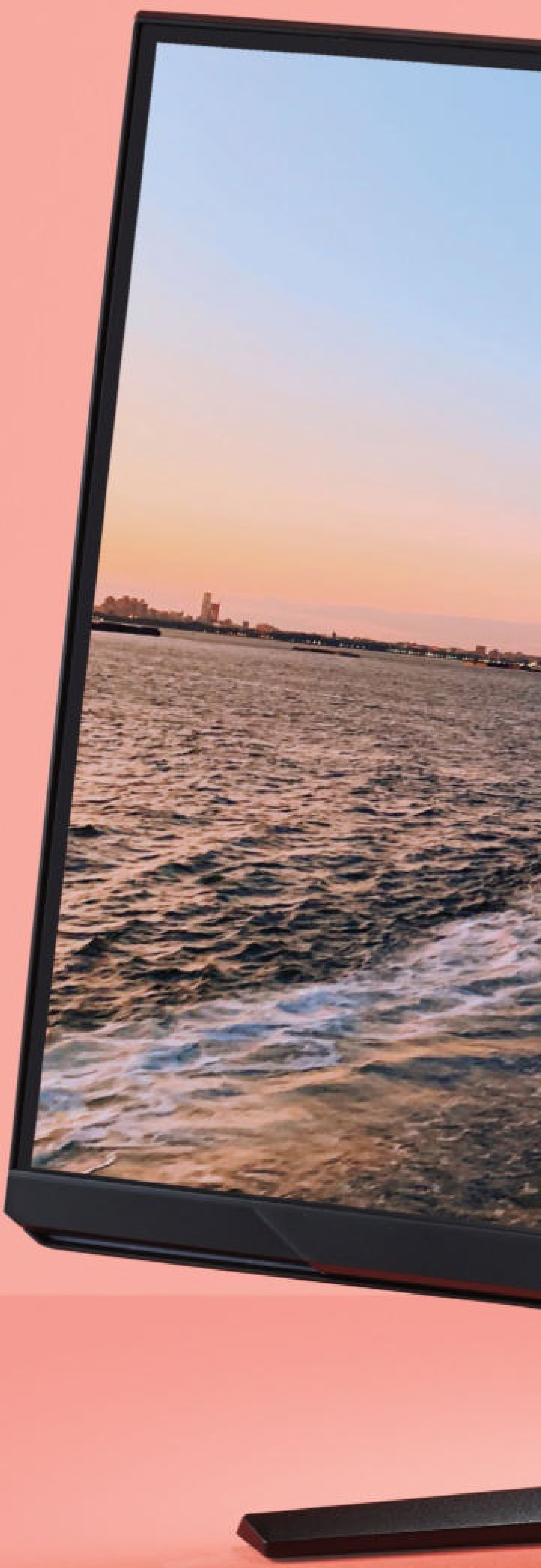
➕ **NEOPHILE** Super quick response times; crazy high 4K refresh rate; Mini-LED backlight is sometimes spectacular.

➖ **MNEOPHOBE** Mini-LED backlight is also flawed; no USB-C connectivity; not cheap.

$1,299, www.samsung.com

SPECIFICATIONS

Screen size	32-inch
Screen curvature	1000R
Aspect ratio	16:9
Panel type	VA
Brightness	2,000nits (peak)
Contrast ratio	1,000,000:1 (Static)
HDR	Quantum HDR 2000
HDR format	HDR10+
Resolution	3,840x2,160
Response time	1ms
Viewing angle	178°(H)/178°(V)
Color gamut	95% DCI Coverage
Refresh rate	240Hz
Mini LED local dimming	1,196 zones



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Samsung's Neo G8 is an incredibly well-rounded monitor.

Lenovo's Yoga Slim 9i looks and feels like a premium laptop.

Lenovo Yoga Slim 9i

A touch of class from the Yoga lineup

LENOVO IS NO STRANGER to exciting new designs featuring multiple screens and quirky new functions, especially with its Yoga range of products. However, these attention grabbers shouldn't take the limelight away from the company's more conventional offerings. The Yoga Slim 9i follows a typical laptop format, albeit with a few tricks up its sleeve. With its 'Oatmeal' colorway and chrome finish, Lenovo appears to have gone down the premium route for the Yoga Slim 9i. Is this a sensible purchase, or should you opt for one of Lenovo's more curveball options?

Straight out of the box, we can safely say that Lenovo has hit the 'premium' nail on the head—and that's before we've even booted up the laptop. Every contact point on this device is smooth and finished to a high quality, the chassis is all aluminum and super thin at just 0.6-inch thick, and it's a sturdy machine with no creaking or rattling when opening it. There are no sharp corners here, Lenovo has rounded every one so that it's comfortable when you're using it on your lap.

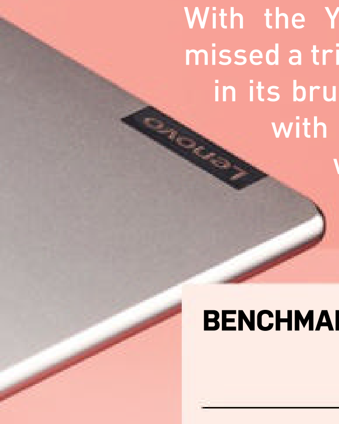
The hinge is smooth and holds the screen perfectly to ensure there's no wobbling. It also folds almost completely flat, and it's small details such as this that highlight the overall quality of a laptop. With the Yoga Slim 9i, Lenovo hasn't missed a trick—this thing looks beautiful in its brushed satin oatmeal colorway with chrome accents across the whole device. It has a slim bezel and subtle branding too and, for a productivity-based laptop, the discrete and minimalist design creates as little distraction as possible between you and your work. As an overall package, this is a sophisticated piece of tech.

Away from the design, another stand-out feature of the Lenovo Yoga Slim 9i is its display. This laptop has a 14-inch multi-touch OLED panel running at a resolution of 2880x1800, or 2.8K. That isn't your typical resolution for a laptop, of course—most are either 1080p, 1440p, or 4K. There is a 4K option, but that display only runs at 60Hz, whereas our 2.8K panel can run up to 90Hz and while that doesn't sound like a big difference, it makes everything run much more smoothly. Plus, this 2.8K panel offers an outstanding color range that really pops, with deep blacks and great contrast too.

The Slim 9i's keyboard is easy to type on, has a low profile, and has quiet feedback and a nice white glow that disperses evenly under the keys. Sure, laptop keyboards aren't a patch on mechanical boards, yet you wouldn't really want one of those on a device as subtle and premium as this.

Below the board is the trackpad, which is large for a 14-inch laptop, responsive, feels sturdy, and is all you need if you aren't using a mouse. On either side of the keyboard, you'll find two speaker grilles with three additional ones underneath. Lenovo has teamed up with Bowers & Wilkins here and the sound quality is excellent for a laptop. Usually, laptop speakers get overlooked—more often than not headphones will be used—but again, Lenovo has gone above and beyond here. The same can be said for the integrated webcam, which at 1080p 60fps, is good enough for conference calls. It also has a camera shutter toggle on the side for privacy.

So what's inside this machine? Our model has a 1TB NVME M.2 2280 PCIe 4.0 SSD, 16GB of DDR5 running @5600MHz, and an Intel Core i7-1280P chip behind the wheel. This is a 14-core 20-thread processor with Intel's hybrid architecture. It's a snappy processor and scores well in our Cinebench test results, making it perfect for on-the-go editing, work, and designing. This laptop would be great for anyone who needs to work on the go as it is extremely portable. It's great for media consumption due to its stunning display and crisp speakers. The overall build quality is fantastic and it certainly feels like a well-put-together device. If you're after an extremely well-rounded laptop with a great fit and finish, the Lenovo Yoga Slim 9i could be the laptop for you. **–SAM LEWIS**



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VERDICT

9

Lenovo Yoga Slim 9i

➕ **YES, YES AND YES** Superb build quality; velvety smooth OLED display; solid performance; great premium package.

➖ **SLIM PICKINGS** Not good for gaming; lack of ports; slow SSD speeds.

$1,499, www.lenovo.com

BENCHMARKS

	ZERO-POINT	
Cinebench R23 Single-Core (Index)	1,865	1,243 (-33%)
Cinebench R23 Multi-Core (Index)	13,186	9,826 (-25%)
CrystalDisk QD32 Sequential Read (MB/s)	7,072	3,574 (-49%)
CrystalDisk QD32 Sequential Write (MB/s)	5,228	2,193 (-58%)
3DMark Fire Strike Extreme (Index)	2,420	5,442 (125%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of the teenage engineering computer-one build from our September 2022 issue, featuring an Intel Core i5-12600K, 32GB (2x 16) of PNY XLR8 Gaming REV GB DDR4-3200, and 1TB Samsung 980 Pro w/ Heatsink PCIe 4.0 NVMe SSD. No manual CPU overclocking.

SPECIFICATIONS

CP U	Intel Core i7-1280P @1.80GHz
Graphics	Intel Iris Xe Graphics
RAM	16GB DDR5 @5600MHz
Screen	14-inch 2.8K (2880 x 1800) Multitouch OLED @ 90Hz
Storage	1TB NVME M.2 2280 PCIe 4.0 SSD
Ports	3x Intel Thunderbolt 4 (DisplayPort 1.4, power delivery, 40Gps data transfer), 3.5mm headphone/mic
Connectivity	Wi-Fi 6E, 802.11ax 2x2, Bluetooth 5.1.
Battery life	Up to 11.7 hours
Weight	3.02lbs
Size	0.6 x 9.0 x 12.5-inches

Linksys Atlas Pro 6 (AX5400)

Wi-Fi 6 mesh system at an accessible price point

MESH NETWORK systems can easily become expensive, especially when they incorporate newer technology such as Wi-Fi 6. The Atlas Pro 6, available in one, two, and three-node kits, is actually pretty reasonable when judged against the competition, with this three-node kit coming in at $350. For anyone living in a busy household with lots of connected devices, this could be considered money well spent, especially if it allows everyone to get a stable connection no matter which room they're in.

Each Atlas node is shaped like a tower, with sharp squared-off edges, and a perforated top. Thankfully, they're relatively compact at 11-inches high and 3.4-inches wide, so will fit into tight spaces, and they look good enough in their white finish that you can put them anywhere without them being an eyesore. Unlike previous Linksys mesh nodes, they now come with plenty of connectivity, including a 1GB WAN ethernet port and 3GB LAN ports per node.

Setting up the Linksys network is easy enough, though a little time-consuming. Each node has to be woken and connected using the Android or iOS app. Luckily, the app does all the work and you can leave your phone near the node while it runs through the installation. After that, you don't often need the app, as a subtle LED light on top of each device lets you know what's happening, with a blue light when everything is as it should be, yellow if it's been disconnected from another node, and red if there's no connection at all.

As a dual-band Wi-Fi 6 network, the Atlas Pro 6 has the potential to cover up to 5,400sqft, depending on how many nodes you have set up. You'll only be able to make the most out of Wi-Fi 6 if you have up-to-date devices released in the past three years. Older phones and laptops will be limited to Wi-Fi 5 connectivity, which is still supported by this system.

Splitting your connected tech into two bands depending on their needs and priority level, the Atlas Pro 6 has a 2.4GHz channel and a 5GHz channel with 160MHz. By dividing them up, you relieve the pressure, meaning you'll be able to do more online simultaneously.

Each node will let you connect more than 30 different devices at once, so if you buy the three-pack you can have around 90 devices connected. That's not the best in class, but it should be enough for most home settings and, for this price, it's pretty impressive. You should never expect to reach the quoted speeds in the real world, but this network will easily deal with one person streaming Netflix, another playing an online game, and another browsing the web. The most likely limit on your bandwidth is going to be on the internet service coming into your home.

Testing the Atlas Pro 6 against the router provided by an Internet Service Provider, we were able to reach 37.6Mbps download and 16.7 upload speeds using a Wi-Fi 6 device on the Atlas, against just 12.5Mbps download and 14.6Mbps upload with the standard router.

The Linksys app is basic but easy to navigate, but if you want advanced features, such as Quality of Service rules, you should still have a proper router on your system. However, the app lets you switch on a guest network, run speed tests, as well as create a list of devices you want to give priority. There are also parental controls to block certain websites or control access hours.

If you've spent the last few years collecting Wi-Fi 6 devices, now could be a good time to look at upgrading to a compatible mesh system, such as the Atlas Pro 6, especially at this price. It offers a quick and easy way to upgrade, several packages to fit the size you require, and will be effective at improving the performance of the Wi-Fi weak spots in your home. **–YASMINE CROSSLAND**

VERDICT
7

Linksys Atlas Pro 6 (AX5400)

+ **MULTI NODE** Up to 30 devices per node; Dual-band network (2.4GHz/5.0GHz); Easy to set up and use.

− **NODE THANKS** Basic software and features; Not as powerful as rivals; Nodes lack USB ports

$350 (Three-node kit) www.linksys.com

SPECIFICATIONS

WiFi bands	Dual-band
WiFi speed	AX
WiFi technology	WiFi 6 (802.11ax)
Coverage	6,000+ sqft
Ethernet ports (per node)	1 Gigabit WAN, 3 Gigabit LAN
Memory	256MB Flash, 512MB RAM
Dimensions (HWD)	11.2 x 3.4 x 3.4-inches
Weight (per node)	1.5lbs
Operation modes	Wireless Bridge, Wireless Router
Processor	1GHz Dual-Core
Antennas	Five internal

The Linksys Atlas Pro 6 offers Wi-Fi 6 mesh for a highly reasonable price.

Intel NUC 13 Extreme Raptor Canyon

A sizzling Small Form Factor performance

LAST YEAR, Intel launched the NUC 12 Extreme Dragon Canyon with its desktop Alder Lake CPU, which we proudly featatured on our May 2022 cover. Soon after, it teased the NUC13 Extreme, based on the recently-introduced Raptor Lake processors, and the result is this machine which has also made it on our cover.

For anyone new to the NUC concept, these machines are meant for users who prefer a smaller PC with relatively little tinkering required. The systems come with a chassis, PSU, motherboard, and CPU included—our NUC13RNGi9 contains the Core i9-13900K (Core i7-13700K and Core i5-13600K models are available). That means you just need to pick the DDR5 RAM, storage, and discrete graphics card if required. Our writer Sam shows you how to build such a system starting on page 16.

In our model, the processor's base power is 125W, but the thermal design of the Compute Element plus the chassis allows Intel to configure the processor with a PL1 of 150W and a PL2 of 250W, giving a turbo up to 5.8GHz. The cooling solution for the CPU accommodates a heat sink hanging off the edge of the Compute Element, while the Z690 chipset is used, rather than the newer Z790.

In terms of I/O, this puts every other mini-ITX motherboard to shame, thanks to dual Thunderbolt 4 ports, dual ethernet (including 10 Gigabit Ethernet), six USB 3.2 Gen 2 Type-A ports, and Realtek ALC1220 analog audio ports. The front panel is serviced by a daughterboard to provide a USB 3.2 Gen 2x2 (20Gbps) Type-C port and two USB 3.2 Gen 1 Type-A ports. Basically, it's everything you need.

Those familiar with previous generation Intel NUCs may be disappointed, as the 13th gen model has grown in size. But, so have discrete graphics cards, which has forced Intel's hand. The result is improved ease of installation and the ability to install triple-slot GPUs up to 317mm. The PSU also sees an upgrade, moving to a 750W modular one (compared with 650W in the Dragon Canon NUC), while retaining the 80+ GOLD rating. As Sam found, that's enough room and power for an Nvidia RTX 4070Ti GPU.

RAM can be installed simply by opening up the chassis, whereas installation of M.2 SSDs requires the removal of the Compute Element from the baseboard, but this is not difficult. The installation of the GPU is easier than ever thanks to the room in the box, while also resulting in better airflow to keep things cool.

The system uses Intel's VisualBIOS, which features a modern interface with enthusiast options to fine-tune the performance. Not that you'll need it for Intel's 13900K, which is a beast of a CPU. As you can see from the benchmarks, overall performance is a significant step up from the i9-12900 in the NUC 12 Extreme Dragon Canyon, although those looking for a super-compact workstation will have to factor in the increased size of the 13th-gen model. Those looking for a Home Theater PC will be pleased with the 49W power consumption when idle, which is higher than before, but still economical. In tests with a graphics card installed, none of the components went above 85°C, which is another good sign.

Intel has done a great job with its new NUC. At around $1,599 (plus extras), it isn't cheap, but it'll be hard to find an easier to configure mini-PC. If you're looking for a small but mighty PC, it's one of the best options available. **–GANESH T S**

VERDICT

8

Intel NUC 13 Extreme Raptor Canyon

+ EXTREME Supremely powerful CPU; easy to upgrade; small form factor.

– TAME Boring looks; larger case than previous; won't power or house absolute top-end GPUs.

$1,599, www.intel.com

BENCHMARKS

	ZERO-POINT	
PCMark 10 (Overall)	9,567	12,734 (33%)
Cinebench R23 (Single Core)	1,989	2,244 (13%)
Cinebench R23 (Multi- Core)	18,039	32,469 (80%)
7-Zip 21.7 Compression Rate (MBps)	56	133 (138%)
7-Zip 21.7 Decompression Rate (MBps)	1,134	2,101 (85%)
Power consumption, idle (Watts)	43	49 (14%)
Power consumption, maximum (Watts)	425	690 (62%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of the Intel NUC 12 Dragon Canyon, featuring an Intel Core i9-12900, Mushkin Redline 64GB DDR4 RAM, and Western Digital WD_BLACK SN770 1TB. NUC13 system uses Kingston Fury Impact 32GB DDR5-4800 RAM and Kingston Fury Renegade 1TB SSD.

SPECIFICATIONS

CPU	Intel Core i9-13900K
Chipset	Intel Z690
TDP	125W
Number of internal drives supported	5 (M.2 and 2.5in drives)
Max. memory size	64GB (DDR5 SODIMMS, 2x channels max.)
Front I/O	USB 3.2 Gen 2x2 (20Gbps) Type-C port, 2x USB 3.2 Gen 1 Type-A ports
Rear I/O	10 GbE RJ-45, 2.5 GbE RJ-45, Killer Wi-Fi 6E AX1690i, HDMI, Realtek ALC1220 analog audio ports, 2x Thunderbolt 4 ports, 6x USB 3.2 Gen 2 Type-A ports
PSU	750W 80+ GOLD
Dimensions	337 x 318 x 129mm
Weight	7kg

intel
CORE
i9

If you want outrageous power in a tiny box, the Intel NUC13 is for you.

Netgear Orbi RBK763

The best WiFi 6 mesh networking kit

NETGEAR'S ORBI systems have carved out a niche at the top of the mesh router market with premium products and high-end price tags. The RBK763 three-pack (two satellites and a router) follows this route by being a bit more expensive than its WiFi 6 competition, but does it justify that with a performance to match?

This three-pod system should offer enough coverage for most households at 7,500 sq. ft. These are relatively big and bulky devices at 8.3 x 6.6 x 2.5in, so not as compact as the Amazon Eero Pro, though this size does help with signal performance. The satellites may look nice, but they aren't the easiest pieces of kit to hide away in your home.

The Orbi phone app is all that's needed and we were up and running in around 15 minutes or a little more if a firmware update is required. The app gives plenty of guidance about where to place the satellites and everything is straightforward and easy to follow.

Netgear has done a good job with the subtle light bars on the router and the satellites that reassure you that everything is connected and working. If there's a problem, the colored lights will let you know. Included in the box with the RBK763 system you get the router, two satellites, power adapters for all three, and an Ethernet cable for attaching the Netgear router to your existing router.

Mesh systems have to cope with an array of different house types, and your mileage may vary depending on the layout, location, and size. However, in our two-bed apartment, the units delivered speedy and reliable Wi-Fi to every corner. With one satellite a couple of rooms away from the router and the other upstairs, we got the same speeds everywhere, even in the garden—walls, floors, and glass doors are no problem for this package. Each satellite also has a couple of Ethernet ports, meaning you can also use a wired connection.

Netgear claims you can hook up as many as 75 devices at once and get maximum speeds of 5.4Gbps (which will, of course, depend on factors such as your broadband connection and the age of your connected devices). Crucially though, it's a tri-band router, so as well as 2.4GHz and 5GHz channels for your gadgets, there's also a dedicated 5GHz channel just for the router and the satellites to talk to each other. That's basically the difference between this and the Linksys system reviewed on p80 of this issue, and it means much better reliability, as well as a higher price.

In addition to the mobile apps, there's also a web interface, which gives you access to more advanced settings, such as port forwarding and UPnP. You also get a year of enhanced Armor security protection for free, but thereafter it's a monthly payment, as are the advanced parental controls. If these are important to you, it may be better to look for a more feature-rich router with these included.

The Orbi offers top-notch networking you can rely on, which for many heavy internet users will be more than worth the asking price. For most people, the 760 series is the ideal price point, whereas the more expensive 960 series uses newer technology, such as Wi-Fi 6E, to spread the signal further but for a much higher price. For us though, the 760 series sits right in the sweet spot of price and features and is the best WiFi 6 mesh kit for most people who don't want to spend silly money. **–DAVID NIELD**

VERDICT

8

Netgear Orbi RBK763

+ **WI-FLY** Easy setup; strong performance; reliable signal.

− **WHY BUY?** Bulky units; expensive; no Wi-Fi 6E.

$480 (Three-node kit), www.netgear.com

SPECIFICATIONS

WiFi coverage	7,500sqft
WiFi bands	Tri-Band
WiFi speed	AX
WiFi technology	WiFi 6 (802.11ax)
Processor	1GHz Dual-Core
Memory	4GB eMMC NAND flash, 1GB RAM
Antenna	Six internal
Router ports	Gigabit Ethernet WAN, 3 Gigabit Ethernet LAN
Satellite ports	Two Gigabit Ethernet LAN
Smart assistant support	Amazon Alexa, Google Assistant
Dimensions (HWD)	2.5 x 6.6 x 8.3-in (each)
Weight per node	1.6lbs

orbi
Router
Sync
Ethernet
Internet
DC
Reset

This Orbi kit offers Tri-Band wireless, which offers the best speed and performance.

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Corsair HS65 Surround Wireless

The HS65 has been given a features boost

IT HASN'T BEEN LONG since we had our hands on the wired version of the Corsair HS65 Surround, an impressive sub-$100 gaming headset. Visually, it looked more premium than its $80 price would have suggested and, more importantly, the audio quality was impressive, with encapsulating surround sound. The only thing holding it back was a lack of features, so Corsair has thrown low-latency 2.4Ghz wireless technology into the mix on this upgrade—for a cost, of course. So, is wireless worth the bump in price, or should you save a few bucks and stick with the wired variant?

One of the main selling points of the standard Corsair HS65 was its premium build quality and design for a price of just $80. The headset hasn't altered too much and so the build quality is still impressive, even for its new price of just under $120. Like its wired predecessor, you're getting a lightweight aluminum construction, smooth hinges, and the ability to adjust it to a range of head sizes, which are all important if you're going to be using it for hours on end.

The other elements, such as the heavily padded headband, plush earcups, and soft-touch plastic materials, all add to the headset's quality feel. We're big fans of the white and gray aesthetic, but if you want a sleeker alternative, there's a carbon black variant. The only changes come down to the controls on the headset. The fixed cable on the left earcup is gone, making way for a microphone mute button, volume wheel/EQ control, and a USB Type-C charging port. On the right side, you get the introduction of the Bluetooth multi-function button (MFB), headset status LED, and a power button.

In terms of audio quality, we were impressed with the earlier model, particularly for the price, and even with the increased cost to accommodate wireless, you still get a rich and full soundstage. Sure, it's not going to blow away audiophiles, but it delivers a well-rounded sound. Details are sharp and the immersive Dolby 7.1 surround sound does a great job of providing you with pin-point directional audio. In games, this is vital for competitive scenarios and gives you that extra edge over your enemies. Our only real gripe is that the bass is more prevalent than it needs to be, but this can be altered using an EQ in Corsair's iCUE software.

With the latest version of the iCUE software installed, you also get access to Sonarworks SoundID technology, essentially a test that builds a personalized EQ for you based on your preferences. It's used worldwide in over 100,000 recording studios for use in triple-A games and by top-level music artists, so it's not a bad feature to take advantage of.

Audio quality gets a big tick but that isn't the main selling point for this version of the HS65—that will, of course, be its wireless functionality. It uses either Corsair's low-latency 2.4GHz wireless or Bluetooth 5.2 for a range of up to 50 feet. This is handy for when you are wandering around your house and don't want to take your headset off, such as keeping the music going while making yourself a coffee. The MFB also doubles up as a media control, so it's handy for when you're away from your PC.

Performance-wise, the wireless connectivity is stable and snappy, and we suffered no delay issues or cutouts when gaming. However, this feature brings a slight negative with it—the need for a battery. Thankfully, battery life is impressive, with a full charge giving up to 24 hours of usage. More importantly, a quick charge of only 15 minutes will get you up to six hours of gaming playback so if you find a dead headset, it won't take long to get going again. We must also mention the omnidirectional microphone, as this is just as good as on the wired version. It can now be muted by pressing a button, or by positioning it vertically.

Is the wireless version worth the extra compared with the wired version? In terms of value for money, this version gives you on-the-fly controls, snappy wireless performance, great battery life, and all the perks of the original. These features give the Corsair HS65 Surround wireless more versatility, but if you're using it at a desk and want to save some money, the original is still a great shout.

–SAM LEWIS

VERDICT

9

Corsair HS65 Surround Wireless

⊞ THE FULL PACKAGE Premium design; accurate directional audio; fast wireless connectivity; lightweight and comfortable.

⊟ SO NEAR Not too much cheaper than more premium Corsair offerings.

$120, www.corsair.com

SPECIFICATIONS

Driver type	50mm Neodymium
Frequency response	20Hz-20,000Hz
Impedance	32 Ohms
Connectivity	Low-latency 2.4Ghz Wireless USB Type-A, Bluetooth 5.2
Compatibility	PC, Mac, PS4, PS5, Nintendo Switch, Mobile
Design style	Closed-back
Weight	0.60lbs

© CORSAIR

Roccat Kone Air Wireless

Hi-tech battery-powered mouse

AS GOOD as your current PC setup may be, choosing a dependable collection of peripherals is vital to getting the most out of your rig. Think of it like putting budget tires on a Ferrari or asking an Olympic sprinter to run in a pair of boots. One such key peripheral in your setup that should be top-tier is the mouse. Roccat claims its Kone Air Wireless is ergonomic, lightweight, and great for gaming, while coming in at a budget price of just under $70. So let's dive right in and find out whether Roccat has nailed it or missed the mark.

There are plenty of Kone variants offered by Roccat, but this model is a stripped-down and light option, hence the Air Wireless name. When first holding it, you notice that it's pretty light for a larger mouse, weighing in at 0.26lbs. It's important to note that this weight is when using one battery. This mouse is powered by a AA battery, which isn't exactly state-of-the-art in 2023, but it still has its perks. It can be powered using one battery for a lighter overall weight and also has the option to be powered with two AA batteries for an overall battery life of 800 hours. Plus, they're cheap and easy to find around the home.

That 800-hour figure is impressive, especially if you have some rechargeable alkaline batteries on cycle to switch in and out. To get to the battery slot, you just slide back the piece of plastic where your palm rests. This also reveals the 2.4GHz Stellar Wireless USB dongle, Bluetooth connectivity is also included on the mouse. One issue we have, though, is that Roccat only provides one battery with the mouse, so you won't get that full 800 hours of potential right out of the box.

Despite feeling light, the Roccat Kone Air has good build quality on the whole, especially considering its price tag. The top is plastic but the scroll wheel and sides are made of a grippy rubber that gives you great control at all times. It has an asymmetrical ergonomic design that fits the hand comfortably, giving your thumb plenty of room to rest. This mouse sits in the medium-to-large size range suiting the palm grip method. With these credentials, FPS players are accommodated best when it comes to gaming, but it also makes for a handy productivity mouse as well.

BUTTON CONTROLS

There are a total of seven buttons on the mouse, including the side browser, forward and back buttons, and a multi-function button that sits below your thumb. Pressing this 'Easy-Shift [+]' button down by default allows you to access media controls from your mouse. The left click then becomes the previous track button, the right click is the next track button, the scroll wheel becomes a volume wheel, and the scroll wheel button controls the play and pause functionality.

You can experiment with this button by using Roccat's Swarm software, which allows you to program these buttons to all sorts of different functions, again making it a great tool for productivity. Going into more detail, the Roccat Kone Air uses Roccat's TITAN optical switches that offer snappy speeds and a durability of 100 million clicks. Audibly, these switches provide a light clicky sound.

Internally the Kone Air contains Roccat's Owl Eye 19K optical gaming sensor, which is based on the PixArt PMW3370 sensor. Within the Roccat Swarm app, you can choose between five different DPI sensitivities, which can be altered on the fly using the DPI button below the scroll wheel. We found that even with its default settings, the mouse had a snappy response and a smooth effortless glide due to its lightweight and heat-treated gliders.

As a sub $70 mouse, this ticks a lot of boxes, and we have to admit Roccat has achieved its aim of a lightweight, ergonomic mouse that offers wireless connectivity, plenty of customization with programmable switches, and great grip. On the other hand, the mouse doesn't have a modern USB Type-C connection and instead goes for the AA alkaline battery option. There's also no RGB and the overall design is not exactly ugly but rather lackluster. Despite this, the Roccat Kone Air Wireless has plenty of perks and is still a good buy at this price range. **–SAM LEWIS**

VERDICT 7

Roccat Kone Air Wireless

+ A BREATH OF FRESH AIR Programmable switches; great comfort; grippy rubberized sides.

− CLEARING THE AIR AA-battery powered; no optional cable connectivity; no RGB.

$70, www.roccat.com

SPECIFICATIONS

Sensor	Roccat Owl-Eye 19K Optical Sensor
Sensitivity	19,000dpi
Mouse switches	Roccat Titan Switch Optical (100 million click lifespan)
Battery life	Up to 800 hours (with 2x AA batteries)
Connectivity	2.4GHz stellar wireless via USB-A receiver, Bluetooth 5.0
Weight	0.31lbs (with 2x AA batteries)

Roccat Vulcan II Max

A keyboard that prioritizes looks over substance?

WITH THE KEYBOARD market saturated with models featuring every type of design, gimmick, and accessory imaginable, it's unusual for a larger peripheral manufacturer to think outside the box and create something that looks a bit different. But at first glance, that's what Roccat has done with the Vulcan II Max, a 100 percent full-sized board with an exposed clean design and a vibrant RGB glow. Alright, it's not particularly revolutionary, but it's nice to see this exposed look once in a while.

Construction-wise, the build quality is definitely a strong point for the Vulcan II Max. This is in part due to its aluminum face plate, but mainly comes down to the weight of the overall board. Weighing 2.86lbs, it has plenty of heft and, thanks to three large grip pads underneath, this thing isn't moving anywhere once it's placed on your desktop. Despite its weight, some of the materials used are underwhelming, especially at this price. There are no PBT keycaps here, just ABS, and although you can swap them out, that's not really the point if you've paid over $200 for a keyboard.

The keys themselves have an exposed design that gives the Vulcan II Max a more minimal aesthetic when the lights are off. However, with the lights on, this board would give the Las Vegas strip a run for its money. Powered by Roccat's Aimo per-key RGB, the lights are extremely bright and have great dispersion with plenty of customization available in Roccat's Swarm software. It comes with a comfortable translucent rubber wrist rest, which when connected through its rubber prongs, glows and creates an impressive light show on your desk.

We aren't always fans of RGB lighting but, when it's executed like this, we can be converted. The Vulcan II Max also has another trick up its sleeve with its dual-LED switches that indicate when secondary functions are active. For example, if your CPU/GPU temperatures exceed a certain limit, you can program these keys so that they turn red to let you know, a handy piece of hardware monitoring. Fancy features aside, the keyboard has a few downsides. It isn't wireless, it doesn't have a detachable cable, and it has two Type-A headers, so that's two USB slots taken up on your PC.

EXCELLENT PERFORMANCE

Where the Roccat excels is with its performance, and that's the most important factor here for this gaming keyboard. Sure, its build and lighting are impressive, but it also has some snappy actuation with its linear switches. Specifically, the board uses Roccat's Titan II optical switches, which come in either linear Red or tactile Brown.

Our linear Red switches are buttery smooth, offer a softer clicking sound, and have a quick 1.4mm actuation point and a travel distance of 3.6mm. Optical switches generally have a faster response time than mechanical ones, so it's good to see them on this gaming keyboard. In practice, response times were exceptional, with no tangible delays for an immersive gaming experience.

This model is the bigger brother to Roccat's Vulcan II Mini and that itself comes with many of the same great features the Vulcan II Max board offers. You get Roccat's Titan II optical switches, both have an aluminum faceplate and Aimo Per-key RGB lighting including 24 dual-LED switches. Although it's great these keyboards come packed with these features, it begs the question, other than the greater size, wrist rest, and media controls, is the Vulcan II Max worth $80 more than the Vulcan II Mini?

Many people won't even consider a mini keyboard in the first place so, for some, that choice is a no-brainer. However, it's worth noting if you opted for the larger variant at its steep $230 RRP. Regardless of that, both substance and aesthetics are neatly packed into this Roccat board. It's just a shame about the cable and ABS keycaps. **–SAM LEWIS**

VERDICT
8

Roccat Vulcan II Max Optical Keyboard

⊞ **MAXIMUM** Beautiful RGB; hot swappable key caps; dependable build quality; smooth switches.

⊟ **MINIMUM** Limited connectivity; expensive; non-detachable USB cable; ABS keycaps.

$230, www.roccat.com

SPECIFICATIONS

Switches	TITAN II Optical Red Optical Switches
Switch durability	100 million+ presses
Design style	100% Optical
Connection	2x USB Type-A
Polling rate	1000Hz
Wrist-rest	Translucent detachable palm rest
Weight	2.86lbs

The much-delayed *Forspoken* is here, but unfortunately, it makes for a rough adventure.

ACTION ROLE-PLAYING GAME

Forspoken

An exceptionally middling experience

UNFORTUNATELY, THE much-delayed *Forspoken* might have needed more time in development, as the delivered experience makes for a rough adventure. There are some impressive mechanics buried deep within *Forspoken*, but they're too often swallowed up by classic open-world chaff, a lackluster narrative, and some dreadful animation. The promise of effortlessly juggling several different spells, all while jumping around an attractive fantasy landscape, is held back by the unfortunate reality of what that's actually like—a lovely dream that isn't quite held up by its implementation.

While much has been said about *Forspoken*'s narrative, which includes contributions from Gary Whitta (screenwriter of *Rogue One: A Star Wars Story*), and Amy Hennig (creative director of the *Uncharted* franchise), the game is underpinned by many standard RPG tropes. Protagonist Frey Holland, an orphan from New York, is whisked away to the fantasy land of Athia through a magical portal after unintentionally finding herself as the bearer of a sentient bracelet, Cuff, that will not shut up. Upon arrival, she discovers that the world is in a bad way, with the corruptive Break spreading throughout, and the last remnants of humanity living in the single Break-free city of Cipal.

Frey can mysteriously survive in the Break and also use magic. She reluctantly comes to help the people of Cipal for what are quite selfish reasons. First and foremost, she wants to go home, and the initial set of NPCs point her in the direction of some enemies to fight. But then things get complicated, and there are more enemies to fight, and that gets further complicated, and so on until you're done roughly 22 hours later.

That said, the critical path in *Forspoken* is just one small slice of what the game has to offer. The ruins of Athia are littered with landmarks to find equipment such as cloaks or necklaces, monuments to Athia's magical rulers the Tantas, Break-corrupted infestations to clear out, abandoned guilds to explore, and much more. At no point does it feel like you move out of being within a clear line of sight of something to do on the map, which is both a blessing and a curse depending on your level of investment in the world.

It was clear when *Forspoken* was revealed that a major selling point would be the magical parkour, offering Frey the ability to traverse the world of Athia swiftly and without trouble. In practice, this largely bears out, and scooting across and over the landscape is just as satisfying as it looked in the promotional videos. *Forspoken*'s feeling of density is only further exacerbated by using stamina to quickly and effortlessly zoom about. Frey's movement is initially limited by the relatively small pool of available stamina, though the resource gradually expands throughout the adventure.

The various detours and map markers are a good example of the issue that *Forspoken* has in its magic system, too; there's just so much there, but only a fraction of it is actually necessary. The problem with the relatively massive library of magical spells is twofold. Picking and choosing which spells to invest in can be a bit of a headache, and the vast majority of them become available so late in the game that there's essentially no impetus to even bother doing so—save for a cursory exploration to make use of enemies' vulnerabilities.

Despite spending mana—which can be gained through both leveling up, or simply passing through a font of mana out in the wild—on spells from all the

© SQUARE ENIX

Despite input from acclaimed writers, the story rarely deviates from standard RPG tropes.

Apart from the rare setpieces, *Forspoken*'s main quest is dull.

Getting around by magical parkour is exhilarating, but disappointing when you arrive.

Forspoken is at its best when Frey is ducking and diving in the striking world of Athia.

different elemental schools regularly, we rarely felt the need to mix things up beyond shifting between the different 'schools' of spells. There are essentially four types of spells—support, attack, surge, and purely utility—and I rarely felt compelled to change a support spell to something else instead of simply shifting to a different element altogether.

Forspoken's mistake here seems to be confusing the technical limitations inherent to providing so many options with meaningful choices. Both mechanically and narratively, we cannot think of a single meaningful choice we had to make beyond where to spend our time. After initially exploring all the nooks and crannies of Athia, we chose to focus our attention instead on the main quest and that alone.

It's just unfortunate that said main quest is so dull. Barring a few rare setpieces, *Forspoken* seems to prefer to tell rather than show with one particularly egregious sequence later in the game devoted to revealing exactly what's been going on in full, lest there be any misunderstanding. Even taking *Forspoken* on its own terms, for what it actually does rather than what we would have preferred, it came across as an exposition dump at the conclusion of a plot that didn't exactly endear me to Frey or Cuff, the two main characters.

The kindest thing we can say about *Forspoken* is that it is aggressively fine. The good and bad parts are roughly equal such that it comes to be, in summation, an exceptionally middling experience. The magical parkour is exhilarating, but not really backed up by significance when you get to where you're going, and while half the game might have you moving from place to place, the other half is what you do when you arrive. The wide variety of spells is appreciated, but there's basically no reason to bother beyond a few favorites. *Forspoken* wants to be a game about hope and choice and community, and though it's willing to hit you over the head with those themes explicitly to make sure it gets across, it never manages to instill them organically, which is a shame.

Forspoken shines brightest when its protagonist is dipping, ducking, and diving along the generally striking world of Athia while casting a variety of spells, but the standard fish-out-of-water fantasy story of Frey only subtracts from the experience. **–ROLLIN BISHOP**

VERDICT 5

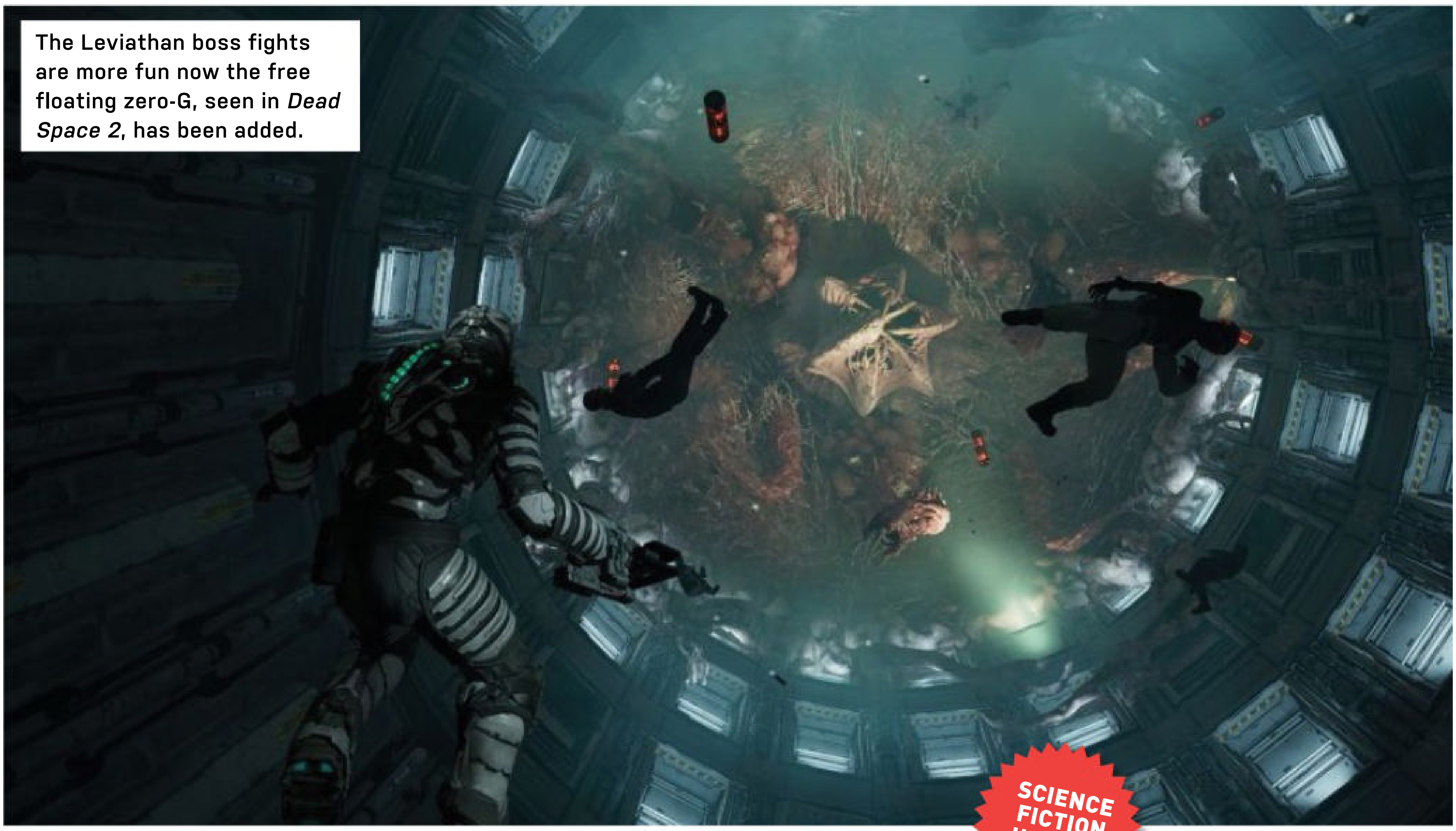
Forspoken

SPEAK ITS NAME Magical parkour; great accessibility options; impactful spells.

FORGET ABOUT IT Story isn't compelling; inconsistent pacing; rough cut-scene animation.

RECOMMENDED SPECS CPU, Core i7-8700K/Ryzen 5 3600. RAM, 24GB. GPU, RTX 3070/RX 6700.

$70, forspoken.square-enix-games.com, M-rated



The Leviathan boss fights are more fun now the free floating zero-G, seen in *Dead Space 2*, has been added.

SCIENCE FICTION HORROR

Dead Space

A definitive remake and a promising precedent

“TWINKLE TWINKLE little star, how I wonder what you are?” a dying woman sings over the elevator tannoy as we climb through the decks of the doomed ship Ishimura. It's a nursery rhyme horror cliche, for sure, but it fits *Dead Space*. This was never a series about exploring the wonders of the universe or space as a wild frontier where the worst evil we can imagine is corporate greed dominating the stars. No, this is a game about how space is downright scary; an abyss into which we gaze and see our nightmares reflected right back. Hard to marvel at the universe with a Necromorph's blades in your gut.

This remake feels petty much like a brand-new *Dead Space*. Sure, it's got the same bleak atmosphere, overarching narrative, and the same familiar old Necromorphs, but it could also be the foundation for a new *Dead Space* moving forward—proof that this survival horror formula is still as strong now as it was when the original launched back in 2008. And a big part of this remake's strength is down to the fact that it builds on what was already there, rather than trying to make something brand new, much like that Necromorph stabbing you.

DEAD MAN WALKING

Isaac Clarke is your average space engineer, hoping to see his girlfriend Nicole after a long time apart. Instead, he finds himself working the worst shift in history. As you bounce from crisis to crisis trying to keep the dying planet-cracker, USG Ishimura, on its last legs, you also have to contend with the ship's crew, now shrieking Necromorphs of all shapes and sizes who want to make friends. Your only defense is an array of sci-fi power tools that turn out to be pretty effective at dismembering angry aliens.

Both your suit and weapons feature new upgrade options.

Dead Space manages more in ten hours than most games do in 30, and that narrative has been further focused upon in the remake. Isaac now speaks and, though his silent yet capable Gordon Freeman-esque characterization in the original game worked, this helps make him feel like more of an active participant in the story. His dialogue does err a little towards action hero at times with lines like “I'm all out of good ideas, so guess what's left”, but you do get more of a sense of him barely keeping himself together as the crisis continues to escalate.

Brutalising Necromorphs is an iconic part of *Dead Space*'s cycle of catharsis—you jump scare me, I reverse-engineer you from existence, and this is how we cope with fear. Along with the great guns, there are also new alt-fire and upgrade options for weapons. The weird bullet cyclone for Pulse Rifle has been swapped for a proximity grenade launcher, and the Line Gun can lay down tripwires. For a Plasma Cutter purist, it's nice to be able to place a perimeter of traps and get a bit more use out of some of the other guns.

Most of the big-ticket boss fights, such as tangling with the Necromorph Hunter in chapter five, play out frame-for-frame—though they definitely look a

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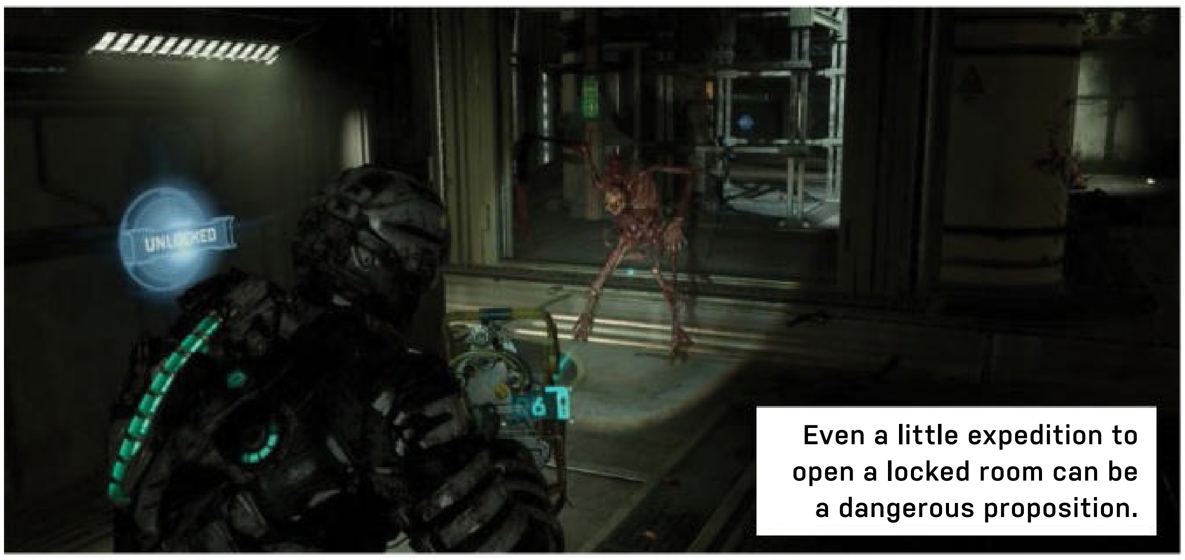
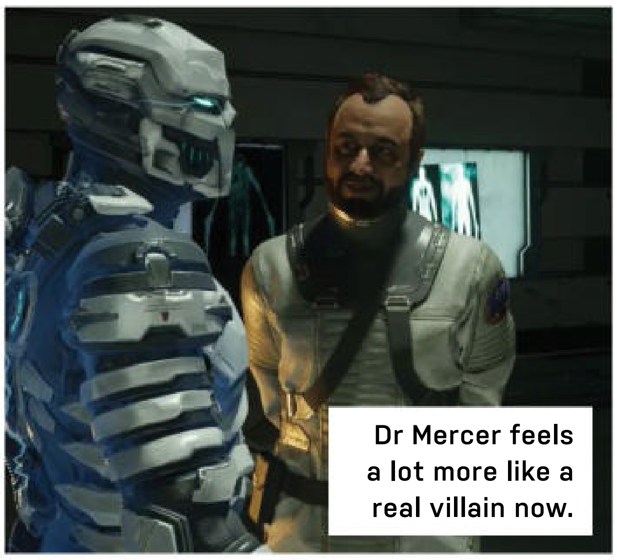


Even a little expedition to open a locked room can be a dangerous proposition.



Dr Mercer feels a lot more like a real villain now.

The Ishimura isn't just a deathtrap for you.

You can expect to be reunited with those Necromorphs.

lot better. That said, both of the Leviathan boss fights are infinitely more fun now *Dead Space 2* and *Dead Space 3*'s free-floating zero-G has been added. The second boss fight, in particular, has been entirely redesigned, with you gliding around the hulking mass and manually commandeering ADS cannons to blast away at its weak points.

FIGHTING GRAVITY

Dead Space's zero-G isn't just for tackling hulking space monstrosities, though. Another change is the inclusion of new no-gravity puzzles, and there's nothing quite like sitting back and floating as you try to figure out some complex space engineering problem. We say 'complex', even though it's usually just grabbing some type of junk with kinesis. These sequences are often a nice respite from fighting Necromorphs, letting you think about something other than alien amputation for a little while, and they are a strong addition to the remake.

It's just one of the many changes that all add up to make this an enhanced version of the original. Circuit Breakers are another example. These power-switchers have been added to older sections as a form of devil's bargain, letting you choose what to turn on and off. You want elevator access? Sure, but it'll cost you either lights or oxygen. It's a pick-your-poison mechanic that lets players select their preferred difficulty modifier and fight through the area.

While there used to be few reasons to return to older areas of the Ishimura, the remake adds locked Security Clearance doors and containers to motivate you to explore for extra items. Since you gain clearance as you progress through the story, you have to remember the location of these secret stashes and return to them once you have the upgrades. Coupled with the new random encounters and visual and audio cues, it goes a long way to making previous areas feel more occupied. Even an expedition to open a locked room can be a dangerous proposition depending on your luck.

ALREADY DEAD

This *Dead Space* remake could also be termed a narrative one. While it doesn't change the major story beats or plot of the original, it does cast them in a completely new light via side quests, holographic logs, new characters, and Isaac being able to speak this time. People like Elizabeth Cross, who you never interacted with directly, are now fully-fledged characters who have their own individual plotlines. The side quests also offer Nicole's perspective on what was happening onboard the Ishimura and give you more insight into the cruelties of the main antagonist, Dr. Mercer, who's now a more fully-developed character.

Yet the overall effect is weirdly frustrating. On one level, it's amazing that so much effort has gone into re-developing the original game's plotline—but at the same time, this effort could have been equally well applied to a new *Dead Space*. It's hard not to feel the same way about the improved sound design and visuals. The remake was built from the ground up using the Frostbite engine and looks and sounds incredible. All of which makes us want to play a new non-remade *Dead Space* game in 2023 with this production quality. Another aspect of the frustration is that another game might have had space to push some of the remake's new ideas and mechanics further.

It takes around 12 hours to complete everything on medium difficulty, but the remake also features a new game with harder 'phantom enemies' and 12 hidden Marker Fragments that unlock an alternate ending, if found. So even though it's a little on the shorter side, this is what *Dead Space* has always been: an intense, momentum-driven experience. Most of all, *Dead Space* is back and *Dead Space* is good. **–SEAN MARTIN**

VERDICT
8

Dead Space

+ DEAD GOOD Terrifyingly gorgeous; more depth than the original; effortlessly confident.

– LOST IN SPACE Lots of map backtracking; source material can feel dated.

RECOMMENDED SPECS CPU, i5-11600K/ Ryzen 5 5600X. RAM, 16GB. GPU, RTX 2070/RX 6700 XT.

$60, www.deadspace.com, M-rated

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Budget Build issues
> Cases, Cases, Cases
> Wrist-based 2FA

Budget Befuddlement

I just finished the article in your December 2022 issue about building a sub-$1,000 AMD machine and thought I'd share my two cents on a couple of aspects.

First, isn't it disappointing that in the current day, "budget" PC hardware can't handle 1080p games smoothly on the highest settings? How long has 1080p been around now... 15 years? And while we say "budget", that GPU costs $300, which is twice as much as the budget CPU. That is a really poor state of affairs.

Second, and I know this is far more subjective, I was surprised at how much emphasis the article, and particularly the summary, put on aesthetics. I know *Maximum PC* is like a hotrod magazine for PCs but for me, aesthetics are the least important part, especially for a cheap PC. If I had to put numbers on it, I'd say performance is 75 percent, upgradability 15 percent, ease of build and aesthetics 5 percent each.

It was a good article and I do like the builds. Just wanted to tease you a bit.

–W. Carr

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: If there's been a theme recently in the letters pages of *Maximum PC*, it's been commentary on our budget builds. Whether it's our cover builds or updates to Budget Blueprints, I receive several letters a month. I share them with Sam, who takes care of both features. He can't win, but not for lack of trying!

We recently adapted the Budget Blueprint builds to bring the cost back down to the all-important $1,000 level, which was off the back of feedback from readers. We actually discussed dropping GPUs entirely from these builds or going super low-end on them, but we think a budget build should still be able to play games—we'd welcome your thoughts, though!

In terms of the Dec. 2022 AMD budget build, I agree that it's frustrating not being able to game in at 1080p high settings on such a system, but there's not much we can do about that. On the GPU costing double the CPU, that's 2023 PC gaming in a nutshell. I just bought a Z790 motherboard for $275 and an RTX 4090 GPU for $1,600—nearly 6x the price!

On the aesthetics though, Sam was keen to show that even on a budget, you could still get a case and RAM with RGB lighting. It's a subjective topic—some love RGB, others hate it—but it used to be the case that you'd have to pay 10-20 percent more for it, whereas Sam's point was that you can now do it on a budget. I personally agree broadly with your percentage breakdown though. For me, bang for buck is everything!

Casing The Joint 1

I find it interesting (or sad) that most ATX computer cases follow the same layout formula, and end up being a variation of the same box format. Can you do a feature on the places to look to find more alternative case styles at differing prices?

I've seen a few efforts of case makers over the years, such as a triangle case, Azza Pyramid, Thermaltake Level 10, and Lian Li Yacht, so I'd love to know of some options along those lines. The "gamer" style cases don't count in my mind because they're often a box format with a garish exterior. I also exclude the custom creations of modders (although many are awesome) because they aren't production cases.

I assume there are neat cases out there somewhere that are never seen by potential customers. I'd be interested in more vertical (tall tower) cases. I'd love to see an NZXT H1 scaled down to mATX or even up to ATX.

–K. Recksiek

Casing The Joint 2

It seems to me that most desktop PC cases are junk. Flimsy, anemic metal frames with as much iron in as a Matchbox car.

When I wander the aisles of my local computer center, I'm disappointed in what manufacturers are putting out. I want a case that's as solid and builder-friendly as the ones I started building in 15 years ago. Nanoxia, a German company, has some nice full tower cases, such as the Deep Silence 5 and 6, but they're expensive. I've never seen Nanoxia cases here in the US, but I'd love to get my hands on one.

↘ submit your questions to: editor@maximumpc.com

Could you recommend some top mid-tower and full-tower cases that you've had experience with? You discuss desktop cases frequently, but they're usually for your budget builds. Big, quiet, and intelligently designed is enough for me.

Maybe you could write a *Maximum PC* article on "Monster Mid-Towers vs. Ferociously Fabulous Full-Towers"? I'd be most appreciative if you could recommend a solid tower that will stand the test of time. **–S. Sherk**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: If you read my editor's letter this month, you'll see that everyone I know seems obsessed with small form factor PCs at the moment and, in conjunction with these letters, it seems like there's some ennui spreading through the community over the state of current ATX cases.

To address the question on rugged ATX cases, I personally love the humble ATX case, as the nature of the job necessitates pretty regular upgrading and chopping and changing of components. Doing this in a big and roomy case makes this process as easy as possible—doing it in a non-standard form factor adds yet more complications. Boring, I know! I've tended to find myself going for Corsair and NZXT's cases for this reason, but we certainly can cast our net wider for a larger feature on cases. Thanks for the idea!

Regarding non-standard cases, it feels as though they've gotten less exciting over the past few years, though having seen some at the Consumer Electronics Show, I'd say one exception is Thermaltake. Its Tower200 was a great-looking compact case, although still box-like in nature, sadly. However, the company is doing some interesting stuff with lighting, magnetic fans, and component placement.

Antec and Cooler Master are also worth checking out for cases that stray from the usual, though they are also mostly box-like. Have you seen any novel cases recently, or are you a case manufacturer who wants to show off your wares? Please let us know.

TOWER200
thermaltake
thermaltake

Thermaltake had some of the best PC cases we saw at CES this year, but they were still distinctly box-like.

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DDR Wars

I just wanted to say, I loved your Holiday 2022 issue with the 8K Gaming Monster article! I was dying to know what a top-of-the-line setup with the latest Intel and AMD chips and RTX 4090 could deliver, as well as how AMD's top chip compared to Intel's in such a configuration. This was a great feature and was nice to see after the past few budget builds! The follow-up test swapping out the motherboard chipset and comparing DDR5 to DDR4 was also insightful.

Keep up the great work! **–A. Arnesen**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Thank you for your kind words, although as they're about a feature I personally wrote, I'm sure some of you will think I made it up!

The amount of budget builds that we were doing at the end of last year was a necessity—not only with the cost-of-living crisis but, for a few months, we were desperate to have some new PC hardware to talk about! Now, we've got the opposite problem, where there are so many new CPUs and GPUs coming through that we can't build with them fast enough to keep up!

Next month, Sam is looking at doing an AMD build with its Zen 4 and RDNA 3 products, but I'm sure as soon as we've done that, the new X3D chips will come along and we'll do a whole new build with them. It's a nice problem to have for the magazine though—better to have lots to cover than nothing at all!

This all-out build was important, as it showed where to best spend your money when upgrading to the latest generation of Intel and Nvidia products. The RTX 4090 was a hefty investment, but the outlay for the motherboard, CPU, and even RAM was much less painful. Even NVMe SSDs continue to drop in price, where it's now easy to spend less than $100 on a 1TB super-fast drive.

2FA on the wrist

I wanted to get in touch about your 2FA Head-to-Head comparison with Authy vs. Google Authenticator (Jan 2023 issue). When I evaluated the popular solutions out there, the most critical requirement was that it had to work on my Apple Watch. That is the one device that I just always have handy (not my phone!). That means it has to be on my smartwatch, whatever OS that watch is running.

For that reason, I use OTP Auth. In my humble opinion, it outshines both Authy and Google Authenticator. It has logos, neatly organizes the credentials in a folder hierarchy, and syncs between all my devices. Oh, and it works on Apple Watch! **–D. Seynhaeve**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: This is a good shout, and something I should have considered in my head-to-head. We try as much as possible to think of use cases beyond our own on *Maximum PC*, and accessing 2FA codes on your smartwatch makes total sense.

I have a Samsung Galaxy Watch5 Pro, which runs on Google's Wear OS, so in the interest of balance, I'd point Android users to an app called Authenticator Pro if wrist-based 2FA is important. I'll stick with the desktop version of Authy, personally, as it's easier to copy and paste the codes! ⏻

THE BUILDS

THIS MONTH'S STREET PRICES...

BUDGET

LAST ISSUE, we paid more attention to the overall costs of the budget builds and tried to level the playing field. With increases across the board for PC components, our costs had risen to the point where they weren't exactly budget builds anymore. So we made a few adjustments to bring prices down while still offering well-rounded PCs. With changes to the PSU, GPU, SSD, and HDD for the AMD machine, we managed to bring the price down, but a few extra swaps this time around have lowered it even further.

First, we swapped out our ASRock X570 Steel Legend ATX AM4 motherboard and replaced it with an MSI B550M PRO-VDH WIFI Micro ATX mobo. Although it's a smaller Micro ATX form factor board, it does everything we need it to and saves $15. Our biggest saving came when downgrading our GPU, instead of sticking with our ASRock Radeon RX 6600 XT Challenger D OC 8GB, we opted for a 6500 XT card, an Asus TUF Gaming OC Radeon RX 6500 XT 4GB GPU, saving us $90. We kept the same HDD, SSD, and RAM configuration but chose a smaller PSU as the larger EVGA offering from the last issue was no longer on sale. These changes bring our overall price for the AMD machine down from $921 to $805—a saving of $116. There's a small hit to performance, due to our GPU and motherboard alternatives, but nothing that will be a major detriment to this build.

As for the Intel build, last time we brought down the cost to just under $900 but, as with the AMD machine, we swapped our motherboard for an alternative ASRock model. Although lacking a few features, this is the same B660M chipset and saved $15. We also swapped out the GPU for a similarly performing card, this time an older Asus TUF Gaming EVO GeForce GTX 1660 Ti OC 6GB. With comparable performance to the RTX 3050 card before it, we saved an extra $60. Finally, we opted for the same PSU from the AMD budget machine, bringing the total down to $782.

AMD INGREDIENTS

PART		PRICE
Case	Corsair 4000D Airflow	$95
PSU	450W EVGA 450 BR Bronze 80+ Gold **NEW**	$50
Mobo	MSI B550M PRO-VDH WIFI Micro ATX AM4 Motherboard **NEW**	$119
CPU	AMD Ryzen 5 5600X	$160
GPU	Asus TUF Gaming OC Radeon RX 6500 XT 4GB **NEW**	$199
RAM	16GB (2 x 8GB) PNY XLR8 Gaming EPIC-X RGB DDR4 @ 3200MHz	$60
SSD	500GB PNY CS2140 PCIe 4.0 M.2 SSD	$40
HDD	2TB Seagate Barracuda Compute 7200	$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32

Approximate Price: $805

INTEL INGREDIENTS

PART		PRICE
Case	Corsair 4000D Airflow	$95
PSU	450W EVGA 450 BR Bronze 80+ Gold **NEW**	$50
Mobo	ASRock B660M-HDV Micro ATX LGA1700 **NEW**	$95
CPU	Intel Core i3-12100	$130
GPU	Asus GeForce GTX 1660 Ti TUF Gaming EVO OC 6GB **NEW**	$230
RAM	16GB (2 x 8GB) PNY XLR8 Gaming EPIC-X RGB DDR4 @ 3200MHz	$60
SSD	500GB PNY CS2140 PCIe 4.0 M.2 SSD	$40
HDD	2TB Seagate Barracuda Compute 7200	$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32

Approximate Price: $782

MID-RANGE

AS IN OUR PREVIOUS ISSUE, we tried to cut down our prices for the mid-range machines. It's difficult to do so while maintaining the same power and trying to keep your components up to date. Of course, compatibility also plays a part, and upgrading your CPU may also require a new motherboard or RAM.

So, to keep our mid-range machines balanced, we've made some changes to lower the price and maintain the performance. Kicking off, we swapped out the AMD Ryzen 7 7700X for the AMD Ryzen 5 7600X, saving $80. Granted, the 7 700X is a great chip but for a mid-range rig, the latter fits the bill with six cores, 12 threads, and an impressive max boost core of up to 5.3GHz. We introduced the ASRock Radeon RX 6750 XT Phantom Gaming D OC 12GB GPU last time around, but we're swapping that for a cheaper alternative, the ASRock Challenger Pro OC, which comes in at $409—a saving of $21. We also swapped out the ATX motherboard for a Micro ATX ASRock B650M PG Riptide WIFI mobo, saving a further $55 over the previous ASRock B650E PG Riptide WIFI ATX. That's a total saving of $151 this time.

Applying the same thinking to our Intel mid-range system, we reverted to the Intel Core i5-12600K from an Intel Core i5-13600K. We lose a little performance and efficiency, but the 12600K is more than good enough to power our system and was $60 cheaper. The ASRock Z690 Phantom Gaming 4/D5 motherboard went up from $200 to $230, so we swapped it for the Gigabyte Z690 Gaming X ATX ($200). The GPU had to change too, as the Asus GeForce RTX 3070 Dual V2 OC 8GB hiked up in price, so we brought in the Gigabyte Eagle OC GeForce RTX 3060 Ti 8GB card to replace it, at least until the 3070 cards fall in price. Both machines receive the EVGA 750 BP 80+ Bronze PSU for under $100, but despite making some savings, the increase in GPU price means the total Intel cost hasn't significantly fallen.

AMD INGREDIENTS

PART			PRICE
Case	NZXT H7 Flow		$130
PSU	750W EVGA 750 BP 80+ Bronze	NEW	$90
Mobo	ASRock B650M PG RIPTIDE WIFI Micro ATX AM5	NEW	$175
CPU	AMD Ryzen 5 7600X	NEW	$250
Cooler	Cooler Master MASTERLIQUID ML240L RGB V2		$98
GPU	ASRock Radeon RX 6750 XT Challenger Pro OC 12GB	NEW	$409
RAM	32GB (2 x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz		$120
SSD	1TB Crucial P5 Plus NVME M.2 PCIe 4.0		$94
HDD	2TB Seagate Barracuda Compute 7200		$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)		$32
Approximate Price:			**$1,448**

INTEL INGREDIENTS

PART			PRICE
Case	NZXT H7 Flow		$130
PSU	750W EVGA 750 BP 80+ Bronze	NEW	$90
Mobo	ASRock Z690 Phantom Gaming 4/D5 ATX LGA 1700	NEW	$175
CPU	Intel Core i5-12600K	NEW	$240
Cooler	Cooler Master MASTERLIQUID ML240L RGB V2		$98
GPU	Gigabyte GeForce RTX 3060 Ti EAGLE OC 8GB	NEW	$611
RAM	32GB (2 x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz		$120
SSD	1TB Corsair MP600 PRO NH M.2 PCIe 4.0		$105
HDD	2TB Seagate Barracuda Compute 7200		$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)		$32
Approximate Price:			**$1,651**

TURBO

FOR OUR TOP-TIER turbo machines, building a system with outright power in mind is the priority and keeping one eye on the budget can take a backseat here, well kind of. It would be easy to get carried away with adding unrealistic parts just for the sake of it, but these systems are designed to showcase some of the latest and greatest component configurations, after all. With the recent release of the next-generation Intel and AMD processors, Nvidia's 40 series GPUs, and AMD's latest Radeon RX 7000 series, these systems have some serious heat.

We can finally introduce the latest AMD GPU, the Radeon RX 7900 XTX. In the previous issue, these cards were way over their RRP—you could grab one for around $1,500, but nobody wants to pay $500 over the odds, no matter how special they are. This month, they're back down to where they should be, so out goes the XFX Speedster MERC 310 Black Edition Radeon RX 7900 XT 20GB and in comes the same model, but the XTX variant with 4GB of extra VRAM. There's no denying that this is a mighty powerful GPU—it has a boost clock of up to 2,615MHz and 24GB of GDDR6 this card can easily game at 4K on ultra settings with FPS scores of 90 and above. That's based on benchmarks with the AMD Ryzen 9 7900X, which we also have in this AMD turbo machine. Unfortunately, that's the only change for the AMD rig.

Even that single change on the AMD side is more exciting than the complete lack of activity on the Intel Turbo rig. One possible reason is that we have recently added to both of these systems, so they are certainly future-proofed. The Asus GeForce RTX 4090 TUF Gaming OC 24GB is our weapon of choice here and remains in the build this month as it is still one of the 'cheapest' RTX 4090 cards you can pick up. We use that term lightly as it is still astronomically expensive, but it's the best available at the time of writing. Hopefully, we will get to see a slight decrease in RTX 4090 GPU prices soon as these cards rock, much like the performance of both of these Turbo systems.

AMD INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass	$190
PSU	1000W Corsair RM1000 80+ Gold	$168
Mobo	ASRock X670E PG Lightning ATX AM5	$260
CPU	AMD Ryzen 9 7900X	$420
Cooler	Cooler Master MasterLiquid ML360R RGB 66.7 CFM 360mm	$145
GPU	XFX Speedster MERC 310 Black Edition Radeon RX 7900 XTX 24GB **NEW**	$1,099
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	$250
SSD	1TB WD Black SN850X M.2 PCIe 4.0	$100
HDD	6TB WD Blue 5400 HDD	$80
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$2,744**

INTEL INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass	$190
PSU	1000W Corsair RM1000 80+ Gold	$168
Mobo	ASRock Z790 PG Lightning DDR5 LGA 1700	$210
CPU	Intel Core i9-13900K	$600
Cooler	NZXT Kraken X73 73.11 CFM 360mm	$185
GPU	ASUS GeForce RTX 4090 TUF GAMING OC 24GB	$1,800
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	$250
SSD	1TB WD Black SN850X M.2 PCIe 4.0	$120
HDD	6TB WD Blue 5400 HDD	$80
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$3,635**

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PAPER POWER

More than half of the energy demand at U.S. pulp, paper and paper-based packaging mills is met using renewable, carbon-neutral biomass energy.

Source: American Forest & Paper Association, 2022

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